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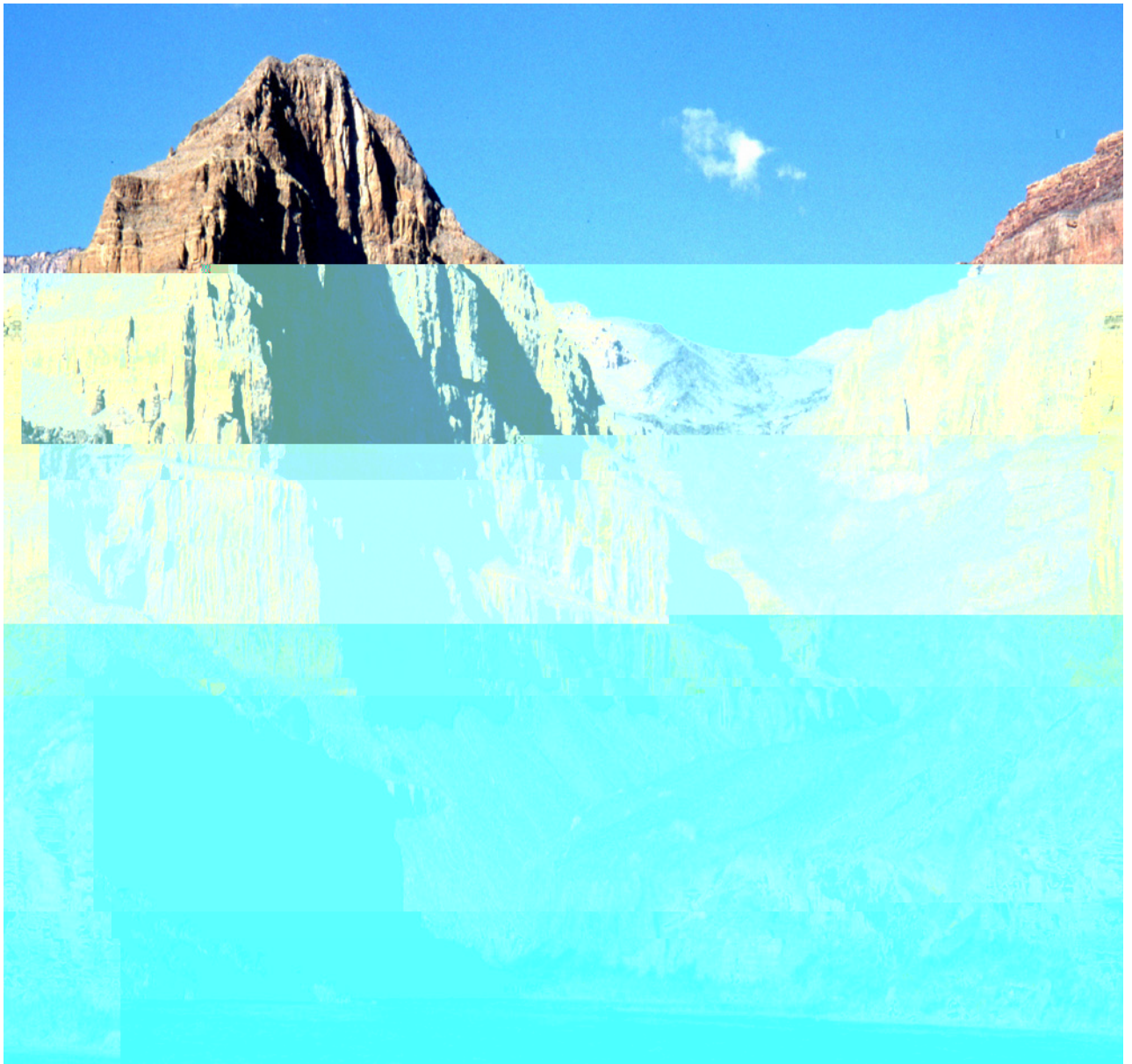
In cooperation with
Arizona Agricultural
Experiment Station



Natural
Resources
Conservation
Service

National Park
Service,
United States
Department
of the Interior

Soil Survey of Grand Canyon Area, Arizona, Parts of Coconino and Mohave Counties



How To Use This Soil Survey

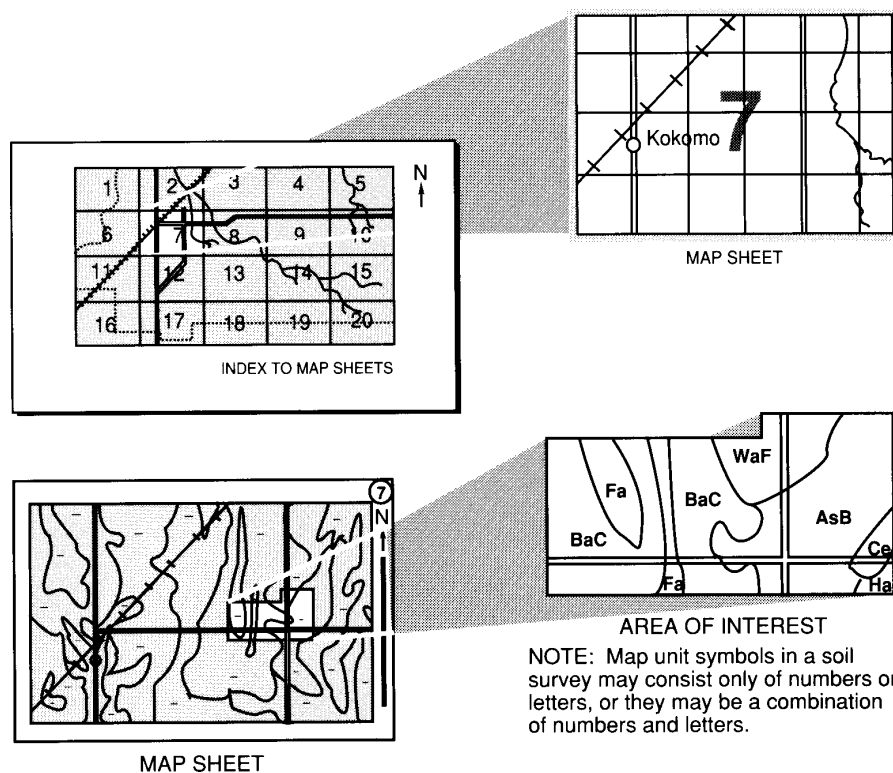
Detailed Soil Maps

The detailed soil maps can be useful in planning the use and management of small areas.

To find information about your area of interest, locate that area on the **Index to Map Sheets**. Note the number of the map sheet and turn to that sheet.

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Contents**, which lists the map units by symbol and name and shows the page where each map unit is described.

The **Contents** shows which table has data on a specific land use for each detailed soil map unit. Also see the **Contents** for sections of this publication that may address your specific needs.



This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, including the Agricultural Experiment Station. The Natural Resources Conservation Service (formerly the Soil Conservation Service) has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 2001. Soil names and descriptions were approved in 2001. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 2001. This survey was made cooperatively by the Natural Resources Conservation Service, National Park Service, and the Arizona Agricultural Experiment Station. It is part of the technical assistance furnished to the Big Sandy, Coconino, Fredonia and Littlefield-Hurricane Valley Natural Resource Conservation Districts.

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Cover: Colluvial toeslopes at the base of cliffs by Lava Falls below Vulcan's Throne.

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Foreword

This soil survey contains information that affects land use planning in this survey area. It contains predictions of soil behavior for selected land uses. The survey also highlights soil limitations and the impact of selected land uses on the environment. This soil survey is designed for the resource management staffs of the Grand Canyon National Park and the Lake Mead National Recreation Area. The information in this report is intended to identify soil properties that are used in making various land use or land treatment decisions. It is very important to note that this soil survey is only intended as a guide and is no substitute for on-site evaluations. It is also important to note that this survey was originally mapped at a scale of 1:24,000 and magnification of scale may lead to erroneous conclusions. Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. These and many other soil properties that affect land use are described in this soil survey. The location of each soil type is shown on the detailed soil maps. Each soil in the survey area is described. Because of inaccessibility and physical safety issues, the map unit descriptions in areas below the rim of the Grand Canyon and outside the Bright Angel Corridor do not contain as much information as the map unit descriptions in the other areas.

Michael Somerville
State Conservationist
Natural Resources Conservation Service

Soil Survey of Grand Canyon Area, Arizona, Parts of Coconino and Mohave Counties

By Bruce A. Lindsay, Richard K. Strait, and David W. Denny

Fieldwork by Bruce A. Lindsay, Richard K. Strait, Fred Fischer, and David W. Denny

United States Department of Agriculture, Natural Resources Conservation Service,
in cooperation with
United States Department of the Interior, National Park Service

General Nature of the Survey Area

The Grand Canyon Area, Arizona, Parts of Mohave and Coconino Counties soil survey, lies entirely in the northwestern part of the state and extends nearly 228 miles along the Colorado River between Lake Powell on the east end and Lake Mead on the west end (fig. 1). The Colorado River, which flows through the Grand Canyon, drains about 250,000 square miles and drops about 2,100 feet from Lees Ferry to Lake Mead (fig. 2). The soil survey covers about 1.4 million acres and consists of the Grand Canyon National Park and part of Lake Mead National Recreation Area north of the Colorado River. About two-thirds of the Grand Canyon is in Coconino County, and about a third is in Mohave County. The Lake Mead National Recreation Area portion of the survey is in Mohave County.

Natural Resources

The Grand Canyon area is abundant in natural resources and scenic beauty. Unparalleled views and recreational opportunities have made the Grand Canyon one of the most desirable tourist destinations in the world. Visitors seek to enjoy this beauty in a variety of ways such as backpacking, river trips, car touring, and air touring. Other activities, such as bicycling, fishing, hunting, and rock climbing, are also allowed within the survey area. The Grand Canyon has approximately 5 million visitors annually.

Ranching is the predominant form of agriculture in the area. Grazing by domestic livestock has been

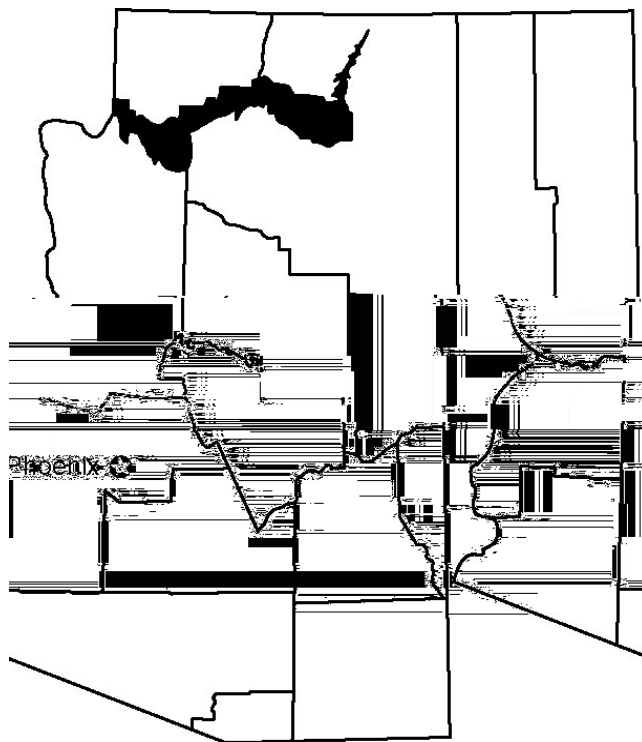


Figure 1.—Location of the Grand Canyon Area, Arizona, soil survey.

restricted in the Grand Canyon National Park but is allowed in parts of the Lake Mead National Recreation Area.

Forests of ponderosa pine occur on the Coconino



Figure 2.—Drainage area of the Colorado River.

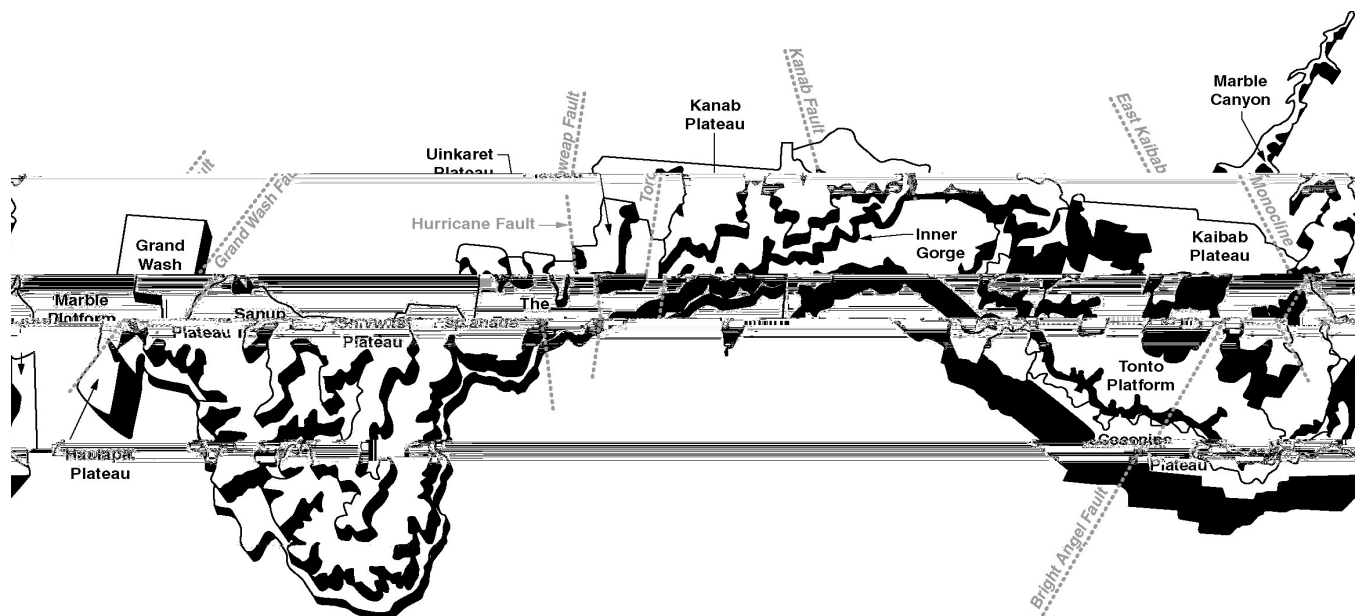


Figure 3.—Physiographic layout of the Grand Canyon Area soil survey.

and Kaibab Plateaus. The Kaibab Plateau also contains forests of white fir, Douglas fir, Engelmann spruce, subalpine fir, and aspen. Proper management of these forests requires prescribed burns and mechanical thinning. Most of the soils in these forests have a high clay content and are subject to rutting from heavy mechanical equipment. Fortunately, many of the soils on the Kaibab Plateau have a 2-foot-thick loamy surface with many rock fragments, making them resistant to rutting and compaction. They are not very conducive to tree planting, however.

Wind and water erosion is a major concern in the area. Erosion can damage areas such as paths and trails, construction areas and areas where the grass cover is lost. Beaches along the river are especially affected by water erosion, and many archeological resources have been damaged.

Some of the most scenic areas are in the side canyons where perennial springs and riparian areas exist. Many rare plants and animals live in these areas.

History and Development

The Grand Canyon area was home to many people prior to the coming of the Europeans. Piute, Hualapai, Havasupai, Shivwits, Navajo, and Hopi were all endemic tribes present when the Spaniards first

arrived. In 1540, Hopi Indians guided a party of 13 Spaniards led by Captain Don Garcia Lopez de Cardenas to the southeastern rim of the Grand Canyon in search of lost cities of gold. In the following three centuries only two other European visits were reliably recorded.

By 1861 the War Department had taken some interest in the area but it was not until 1869 that General John Wesley Powell led his now famous expedition of 10 men down the Colorado River for the first time. By 1949 about 100 Europeans had traveled though the interior river corridor (Beus & Morales, 1990; Belknap, 1969). These were mostly river runners, scientists, and prospectors.

In the early 1900's the vicinity of the canyon became quite popular, and in 1919 Congress established Grand Canyon National Park. Today, the park is visited by millions of people every year, and thousands of them routinely take river trips and hike through the canyon interior.

Physiography

The Grand Canyon National Park occurs on the Colorado Plateau, a vast uplifted tableland that includes large portions of Arizona, Colorado, New Mexico, and Utah. The Grand Canyon is about a mile deep in many places. The South Rim near Grand

Canyon Village is about 7,000 feet above sea level, and the North Rim of the Kaibab Plateau is about 8,000 feet.

The land surrounding the Grand Canyon consists of six local plateaus and one low platform, all of which are bounded by faults or monoclines (fig. 3).

North of the Grand Canyon, the Shivwits Plateau is bounded on the west by the Grand Wash Fault, a north-trending normal fault, and on the east by the Hurricane Fault, also a north-trending normal fault. East of the Shivwits Plateau, the Uinkaret Plateau and the Kanab Plateau are separated by the Toroweap Fault, and the Kanab Fault separates the Kanab and Kaibab Plateaus. The Kaibab Plateau is separated from the Marble Platform to the east by the East Kaibab Monocline. The Coconino Plateau is separated from the Hualapai Plateau to the west by the Hurricane Fault (Beus and Morales, 1990).

Other important normal faults which occur in the Precambrian basement complex in the eastern Grand Canyon are north and north-west trending and are spaced from 15 to 20 miles (24-32 Km) apart. The principal fault zones in the eastern Grand Canyon include the Butte, Phantom-Cremation, Crystal, and Muav faults. An older set of Precambrian reverse faults trends northeast; the most prominent is the Bright Angel Fault. These faults are significant in that they are the source of the side canyons with their unique habitats and microclimates. Deposition of sediment in the main channel of the Colorado River is the source of the river's many notorious rapids (fig. 4).

Geologic History

The Colorado Plateau is unique because the thick sequence of sedimentary rocks is relatively



Figure 4.—Granite Rapid formed as the result of debris flows from side canyons that deposited sediment in the river channel.

undeformed in spite of a long history of severe tectonism and orogeny in the western part of the North American Plate. This lack of deformation is the result of the extensive faulting in the Precambrian basement complex (Huntoon, 1990). These faults have gone through many periods of recurrent displacement. They were active in the Precambrian and throughout the geologic history of the Colorado Plateau. Since Late Cretaceous, this part of the North American continent has undergone major periods of compression and uplift during the Laramide Orogeny.

Orogenies are geologic events that cause mountain building, uplift, and deformation by compressional forces. They are the result of the collision of two continental crustal plates, or the result of a crustal plate colliding with an oceanic plate. The collision of crustal plates and oceanic plates causes volcanism and compression. Crustal/oceanic plate collisions are more common than collisions between crustal plates. The oceanic plate is denser and slides beneath the continental plate, resulting in what is called a subduction zone. If the rate of subduction is slow, the oceanic plate sinks down into the asthenosphere (upper mantle) and begins to melt. The magma rises and melts through the continental crust and forms volcanoes. Such is the case with the West Coast of North and South America and the so-called "Ring of Fire." In contrast, if the rate of subduction is fast, the oceanic crust does not have time to sink. It underplates the continental crust and buoys it up, causing uplift and compression. Scientists believe that this is what happened in Late Cretaceous time to cause the Laramide Orogeny. This event caused the uplift of the Colorado Plateau to approximately where it is today (Huntoon, 1990).

As all this tectonism was going on, and other regions were being folded, deformed, and stretched out, the Colorado Plateau was relatively unaffected. The reason for this is that the individual plateaus would rise or fall along these faults as the compressional or uplifting influence passed through the region. The result was only minor folding, deformation, and contact metamorphism in the immediate vicinity of the fault that left the plateaus unaffected (Huntoon, 1990).

Lake Mead National Recreation Area is mostly in the Basin and Range Province of the Mohave Desert. The break between the Colorado Plateau and the Basin and Range consists of the Grand Wash Cliffs, a very large normal fault (Huntoon, 1990). The Basin and Range is a region of major extension initiated in the Late Oligocene (Huntoon, 1990). It was the result of the North American plate colliding with East Pacific Rise.

The area west of the Grand Wash Cliffs was down-dropped and offset along the fault as the result of extension. This vertical displacement is estimated to be as much as 16,000 feet (Lucchitta, 1990). This area became a major basin and is called the Grand Wash Trough. Much sediment was deposited in this basin, and it is referred to as the Muddy River Formation. However, the source of the sediment was not the Colorado River, at least as it currently flows. The Muddy River Formation is primarily lacustrine, low energy deposits. There is geologic evidence that the Western Grand Canyon had not eroded in its present course prior to 4 to 6 million years ago (Lucchitta, 1990).

Geologists think that prior to the Oligocene-Miocene extension, the Colorado River flowed northwest around the Kaibab Plateau at a fairly gentle grade through the Arizona Strip region and northwest of the Virgin Mountains, and that this is the source of the Muddy River Formation. As rifting occurred, the basins were internally drained and became marshy salt flats. At times, these flats were conducive to the deposition of gypsum. As subduction of the East Pacific Rise continued, the Gulf of California began to form and provided a drainage outlet for the basins. With a drainage outlet now established, and as uplift of the Colorado Plateau continued, the drainage gradient became quite steep. A drainage that had become established on the west edge of the Grand Wash Cliffs extended itself eastward through headward erosion until it captured the northwesterly flowing Colorado River. With a perennial source of water, a shorter channel length, an external drainage outlet to the Gulf of California, and slow continued uplift of the Colorado Plateau, regional erosion began to occur.

The lava from the eruption of Vulcans Throne in Toroweap Valley flowed into the current level of the river. This lava has been dated at about 1.2 million years old, suggesting that the majority of the erosion of the Grand Canyon as we know it today was completed more than 1.2 million years ago. Comparing this date with the 4- to 6-million-year age of the basalt flows on Kelly Point (Lucchitta, 1990), it is reasonable to conclude that Grand Canyon took approximately 5 million years to form and is, in a geologic time frame, very recent.

The Grand Canyon area occupied a position on a westward sloping continental shelf during the Paleozoic Era (Huntoon, 1990). Northeastern Arizona was actually marine shoreline from about the Precambrian through the late Mississippian. During this time sediments were deposited in a marine environment, thickening seaward to the west. Terrestrial influences

Plateau. It is coherent enough to be a cliff-former and forms the rim of the Grand Canyon. A stratigraphic column for the formations in the Grand Canyon is shown in figure 5.

Permian was a time when the northern part of the state went from fluvial deposition of the Esplanade Sandstone and Hermit Shale to the eolian deposition of the Coconino Sandstone. Subsidence resulting in the Grand Canyon Embayment allowed shallow seas to invade the land once again, and the Toroweap Formation was deposited. The Kaibab Formation was later deposited as sea levels continued to oscillate (Nations and Stump, 1981). The Kaibab, Toroweap, and Coconino Formations are all conformable sequences, meaning there was not a period of erosion between the times of their deposition. Because of facies changes and lateral limits of deposition caused by the Sedona Arch and the Kaibab Arch, the formations may grade into one another laterally in some places.

The Kaibab Formation was deposited in a time when

a shallow marine shelf extended across northern Arizona and into southern Nevada. At times the shelf exceeded 200 miles in width (Hopkins, 1990). The nearly flat, broad shelf was susceptible to minor changes in sea level that drastically altered the depositional environments. The Kaibab Formation is divided into two members, the upper Harrisburg Member and the lower Fossil Mountain Member. The Harrisburg Member consists of thin units of sandstone,

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brachiopods and corals. However, the Fossil Mountain Member was also subject to variations in sea level and deposits of terrestrial sediment. These conditions resulted in an extremely variable stratigraphic lithology that varies both vertically and horizontally.

The Toroweap Formation was deposited with the first incursion of the sea from the west in the Grand Canyon Embayment (Turner, 1990). Several transgressions and regressions of the sea deposited limestones, sandstones, and evaporites, primarily gypsum. The Toroweap Formation is mostly a slope-former.

The Coconino Formation occurs below the Toroweap Formation and is a prominent cliff former. It is recognizable by extensive cross-bedding typical of windblown sands. In early Permian, northern Arizona was part of a huge desert that extended as far north as Montana (Middleton et al., 1990). The sandstone thickens to the east of the Sedona Arch.

The Hermit and Esplanade Formations lie below the Coconino Formation and are both early Permian in age (Blakey, 1990). The Hermit Formation is a dark red mudstone and siltstone of fluvial origin. It is a slope-former and is exposed throughout the entire canyon (fig. 6).

The Esplanade is a shallow marine sandstone with some eolian influence (fig. 7). It becomes more calcareous to the west and grades into the Pakoon Limestone in the vicinity of the Grand Wash Cliffs and the Sanup Plateau. It forms flat pediments and is most visible on the Esplanade Structural Bench in the western central part of the canyon interior.

The Supai Group consists of three formations named, in descending order, the Manakacha, the Wescogame, and the Watahomigi. These are Pennsylvanian in age and were deposited in a mixed shallow marine and eolian environment. These formations are both cliff formers and slope-formers. They are bright red in color, for the most part, and are the source of the red stain on the underlying Redwall Formation (which is actually gray). The presence of layers of indurated sandstone and limestone interbedded with slope-forming mudstone results in the surface of the formation being very conducive to the formation of ledges. The overall surface of the formations is gently to steeply sloping but there are many horizontal ledges that make this formation very suitable for trail formation. If it were not for the existence of these formations, the vast majority of the canyon would be totally inaccessible except by ropes and pitons.

Below the Supai Group lies the Redwall Formation, which is the complete antithesis of a slope-former (fig. 8). As its name suggests, it is a cliff-former and

forms sheer vertical cliffs hundreds of feet tall. If it were not for side canyons and some fault zones, this formation would provide an impenetrable barrier to the interior canyon. On the east end of the canyon, where it is exposed in Marble Canyon, it is 400 feet thick. It doubles in thickness to about 800 feet thick just west of the Grand Wash Cliffs. The Redwall Formation was deposited in a vast sea during the Mississippian Age. Calcium carbonate was deposited as oolites and from biological sources. The limestone is very pure and dense, and in many areas it has been dissolved by the carbonic acid in ground water and has formed extensive cavern and spring systems. Many of these caverns have collapsed and have become sites of the mineral concentrations referred to as breccia pipes. It is the Redwall that provides the calcium carbonate for the travertine formations that occur at many springs such as Havasupai Falls.

Between the Redwall Formation and the Supai Group is a discontinuous formation called the Surprise Canyon Formation. It consists of clastic and carbonate rocks deposited in eroded channels and karst topography on the surface of the Redwall Formation (Blakey, 1990). It appears as lense-shaped bodies of very irregular distribution.

Below the Redwall Formation are deposits of Devonian Age which have been named the Temple Butte Formation. They occur as channel fill deposits in

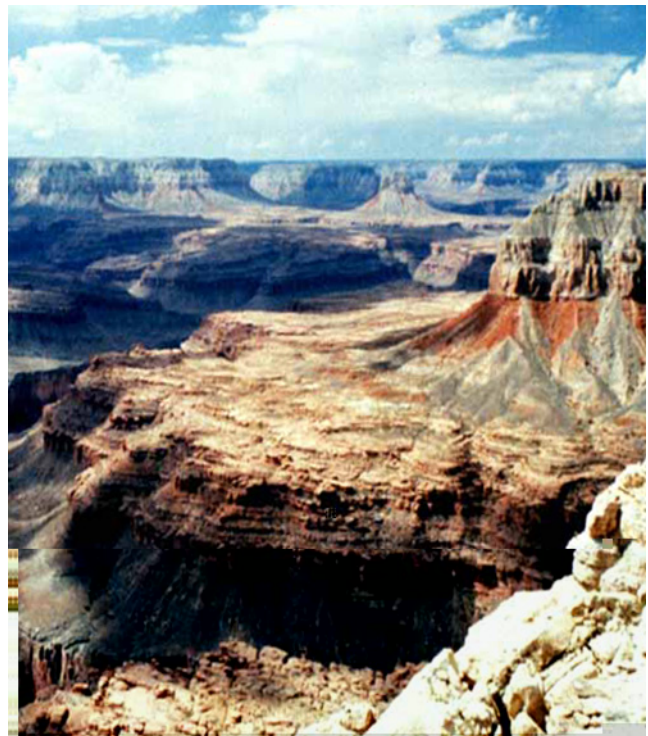


Figure 7.—The Esplanade as viewed from SB Point.



Figure 8.—The Supai Formation overlies the Redwall and is indicated by the presence of many ledges.

the surface of the Muav Formation and are lense shaped and discontinuous, similar to the Surprise Canyon Formation.

The Tonto Group consists of three Cambrian Age formations referred to as the Tapeats Sandstone, the Bright Angel Shale, and the Muav Limestone (fig. 9). These formations were deposited in shoreline to deep water environments (Middleton and Elliot, 1990). The Tapeats Sandstone was deposited in a tidal and strandline environment (beaches). The Bright Angel Shale was deposited in a subtidal, open shelf environment, and the Muav Limestone was deposited in deeper water that was conducive to the precipitation of calcium carbonate. The Tapeats Sandstone is the basal unit and is overlain by the Bright Angel Shale, which is overlain by the Muav Limestone. This stratigraphic sequence is a transgressive sequence and indicates that the ocean levels were rising in this area.

The Tonto Group rests directly on the Precambrian Age Vishnu Schist in most places. The contact between the two formations is referred to as the Great Unconformity (fig. 10). A conformable sequence is one in which sediments are deposited in a continuous sequence without a period of exposure in between. When there is a period of exposure and erosion on a surface prior to the deposition of a subsequent formation, this is referred to as an unconformity or a disconformity. The Great Unconformity is so named because the length of time which passed between the exposure of the Vishnu Schist and other crystalline core rocks and the first deposition of the Tapeats sandstone was four times greater than all of the time it took to deposit and then erode the entire sequence of formations discussed so far. This great expanse of time is attested to by the presence of the Grand Canyon Supergroup. The Supergroup is a sequence of strata of Precambrian Age equal in thickness and complexity to the formations visible today in the Grand Canyon. However, they have been tilted, eroded, and nearly obliterated except for some remnants preserved in down-dropped fault blocks in the older Vishnu Schist. Dating of the Cardenas Lava Formation of the Supergroup indicates that it was 450 million years after the exposure of the Vishnu Schist that the deposition of the Supergroup even started to begin (Hendricks and Stevenson, 1990). It is difficult to conceive that the amount of time between the surface of the Vishnu Schist and the bottom of the Tapeats sandstone is equivalent to the amount of time it took for all of the formations we see in the Grand Canyon today to be deposited, then to be totally eroded away back down to the Precambrian crystalline core rock.

Exposures of the Supergroup can best be seen in Chuar Valley in the eastern part of the Grand Canyon. The Supergroup consists of sandstones, shales, mudstones, and lava that were deposited in the Precambrian Age. The environment of the Precambrian Age was totally different from the environment as we know it today. Our current environment began in the Cambrian and very late Precambrian with the evolution of photosynthesis. Soil formation did not occur in the Precambrian.

Major Land Resource Areas and Land Resource Units

Art Meen, Rangeland Management Specialist, Natural Resources Conservation Service, prepared this section.

A Major Land Resource Area (MLRA) is defined in USDA's National Range and Pasture Handbook as "an association of smaller Land Resource Units (LRU's)

that are characterized by a particular pattern of soils, geology, climate, water resources, and land use" (USDA, 1997). Major Land Resource Areas are larger areas that have broadly similar characteristics, such as the Mohave Basin and Range (MLRA 30) and the Colorado and Green River Plateaus (MLRA 35) found within the area of this soil survey. Land Resource Units are the basic units from which the Major Land Resource Areas are determined. A Land Resource Unit is more narrowly defined by elevation zones, climatic factors such as precipitation and temperature ranges, and one or more plant species that are characteristic of the unit.

Land Resource Units are the first levels of aggregation that are displayed and described at the state level. Soils, map units, ecological sites, and soil interpretations are aggregated into Land Resource Units for areas with common climate, soils, vegetation, and wildlife. They can occupy one continuous area, but will often occupy similar but separated areas across a Major Land Resource Area, especially in areas with significant topography.

Major Land Resource Areas are aggregations of associated Land Resource Units. Major Land Resource Areas are the first levels of aggregation that are

displayed and described at the national level. They are usually a continuous area, or delineation. Major Land Resource Areas are generally synonymous with the terms "ecoregions," "biogeographic provinces," or "ecosystem provinces" used by other agencies, authors, and environmental groups to delineate and describe the major ecosystems of the United States (USDA, 1981).

In the western United States, steep topography creates soil and vegetation layers that can change rapidly and dramatically from the bottom of the valleys to the tops of the plateaus or mountains. These vegetation layers may occupy areas ranging from tens of miles wide to less than 1 mile wide. In areas that show significant topographical influence, these areas are described as Land Resource Units. The entire sequence is aggregated into a Major Land Resource Area that covers a large geomorphic province or region where the soils and vegetative sequences tend to repeat with changes in elevation, temperature, and precipitation.

The portion of this soil survey that is west of the Grand Wash Cliffs falls in MLRA 30, the Mohave Basin and Range. The top of the cliffs and everything to the east falls in MLRA 35, the Colorado and Green River



Figure 9.—The Tonto Platform showing the Tapeats Sandstone (low sloping in the foreground). The Bright Angel Shale and Muav Limestone are at the base of the cliffs in the background. Alluvial fans cover much of the Bright Angel in places.



Figure 10.—The entire stratigraphic column of the Grand Canyon rests unconformably on the Precambrian Age Vishnu Schist. The amount of time that passed between the surface of the schist and the Tapeats sandstone is longer than the time it would take to deposit and erode all of the present sedimentary rocks.

Plateaus. It is important to note that, while this geographic break is suitable for a broad-scale delineation between these MLRAs, they influence each other throughout a transition zone that can be quite broad at times. For example, plant species and entire plant communities more typical of the Mohave Basin and Range can be observed for some distance up the Colorado River from the Grand Wash Cliffs, especially on the hotter slopes along the river corridor. The same intermixing can be observed to a lesser extent in the interior parts of the Lake Mead National Recreation Area and the Grand Canyon National Park along this transition zone.

There are also transition zones between the Land Resource Units that are found within each Major Land Resource Area in the soil survey. Warm exposures can carry a characteristic plant community higher than the typical elevations associated with a Land Resource Unit, and a cold-air or wet drainage can allow a plant community to extend below the typical lower elevation limit. This soil survey area, much of which is

dominated by rapid elevation change and the exaggerated effects of differences in exposure, exhibits these effects in many places.

Major Land Resource Area 30—Mohave Basin and Range

The Mohave Basin and Range is situated between the colder Great Basin Desert to the north and the warmer Sonoran Desert to the south. Elevations range from 500 feet in the lowest valleys to 4,500 feet in the mountain ranges. Broad basins, valleys, and old lakebeds make up most of the area. Numerous north-south trending mountain ranges dissect the valleys and basins, creating the basin and range topographic feature.

Land Resource Unit 30-1AZ—Lower Mohave Desert Shrub

Average annual precipitation for this Land Resource Unit ranges from 3 to 6 inches. Soil temperatures are classified as hyperthermic. Daytime air temperatures can exceed 120degrees F in the summer and rarely get below 25 degrees F in the winter. Typical frost-free and freeze-free periods are 300-365 days and 330-365 days respectively. Snow is extremely rare.

The range in elevation for this Land Resource Unit is generally 500-1,500 feet. The vegetation is mostly widely-spaced creosotebush and Mormon tea, with scattered low shrubs such as white brittlebush, white bursage, and ratany (fig. 11). Common cactus species include a variety of pricklypear and cholla and hedgehog cactus. Perennial grasses are rare on the uplands. They are largely confined to drainages. Drainages and bottoms also contain mesquite and catclaw. These species can be dominant on some bottom sites.

Land Resource Unit 30-2AZ—Middle Mohave Desert Shrub

Average annual precipitation for this Land Resource Unit ranges from 6 to 9 inches. Soil temperatures are classified as thermic. Summer daytime air temperatures often exceed 110degrees F and can reach 120degrees F. Winter air temperatures occasionally fall as low as 15degrees F and have been recorded below 10degrees F. Typical frost-free and freeze-free periods range from 230 to 320 days and from 260 to 340 days, respectively. Snow is rare.

Elevation in this Land Resource Unit generally ranges from 1,200 to 3,400 feet. The vegetation has some similarities to that of the Lower Mohave Land Resource Unit; however, plants tend to be more

closely spaced, and the sites are more productive. White bursage is more abundant, and white brittlebush occurs much less frequently (fig. 12). Creosotebush is the dominant shrub on many sites. Others include Mormon tea, flattop buckwheat, ratany, and winterfat. Joshua trees are scattered across many sites and can be abundant. Cactus species include various pricklypears and chollas as well as hedgehog species. Perennial grasses, such as big galleta and blue threeawn, are scattered on the uplands. Bush muhly is present very occasionally. The perennial grasses increase significantly in the drainages and on eolian sand deposits and are joined by Indian ricegrass and sand dropseed. Mesquite and catclaw are often abundant along drainages and can be dominant in the bottoms. They are scattered across many of the uplands. Wet periods, particularly in the spring, produce large quantities of annual vegetation.

Major Land Resource Area 35—Colorado Plateau and Green River Plateaus

The Colorado Plateau has a thick sequence of flat to gently dipping sedimentary rocks eroded into plateaus and dissected by steep canyons. Volcanic rocks and other pyroclastic materials occur in several areas such as the Uinkarets, Mount Dellenbaugh, and Mount Trumbull/Mount Logan areas.

Millions of years ago, the Colorado Plateau was part of a shelf area bordering inland seas. Many advances and retreats of the water left deposits of sand, silt, calcium carbonate, and clay that, over time, became the geologic formations underlying the area. Faulting and uplifting caused the final withdrawal of the inland seas. Several cycles of erosion and deposition have occurred, all apparently reflecting climatic changes. Geomorphic surfaces in this unit are characterized and



Figure 11.—Typical vegetation of Land Resource Unit 30-1AZ consisting of white brittle bush, white ratany, barrel cactus, prickly pear and creosote bush. This ecosite is Channery Hills 3-6"p.z. on Tapeats Sandstone a few miles upriver from Lake Mead.



Figure 12.—Typical vegetation for ecosite Limy Upland, Deep, 6-9" p.z. in the vicinity of Lava Falls. Creosotebush, barrel cactus, and ocotillo are typical of the plants on Land Resource Unit 30-2AZ.

affected by alternating resistant and weak rock strata. Resistant rocks form ledges, cliffs, mesas, and benches that are separated by slopes and valleys.

Alluvium and eolian deposits cover much of the area and have widely varying ages. The chemical makeup of the different formations as parent material for the soils can have a strong effect on the plant communities.

Land Resource Unit 35-2AZ—Colorado Plateau Cold Desert Shrub

This Land Resource Unit adjoins this soil survey at Lees Ferry and on the plateaus on both sides of Marble Canyon. Its influence can also be seen on the cliffs and colluvial slopes along the Marble Canyon portion of the river corridor (fig. 13).

Average annual precipitation for this Land Resource Unit ranges from 6 to 10 inches. Soil temperatures are

classified as dominantly mesic. However, they can be thermic on shallow soils and warm exposures at the lower elevation limits. Summer daytime air temperatures routinely reach 100 degrees F and can exceed 110 degrees F at the lower elevations. Winter air temperatures often are 10 degrees to 15 degrees F but lows of -20 degrees F have been recorded at the higher elevations. Typical frost-free and freeze-free periods range from 160 to 220 days and from 180 to 240 days, respectively. Precipitation often occurs as snow from December through February. It rarely lasts more than 1 or 2 days at lower elevations but often will persist for 3 or 4 days or more at the higher elevations. The elevation range for this Land Resource Unit is generally 3,500 to 5,500 feet. Shadscale, fourwing saltbush, and Mormon tea are characteristic shrubs on many sites; on others, blackbrush dominates. Grasses such as galleta, blue grama, black grama, and Indian ricegrass can be abundant on some upland sites.



Figure 13.—View of Marble Canyon in Land Resource Unit 35-2AZ.

Alkali sacaton and vine mesquite are found on the bottom sites.

Land Resource Unit 35-3AZ—Colorado Plateau Sagebrush-Grassland

Average annual precipitation for this Land Resource Unit ranges from 10 to 14 inches. Soil temperatures are classified as mesic. Daytime air temperatures in the summer are commonly 95-100 degrees F and occasionally exceeds 105 degrees F. Winter air temperatures can regularly fall below 10 degrees F and have been recorded below -20 degrees F. Typical frost-free and freeze-free periods last from 145 to 175 days and from 165 to 195 days, respectively. Precipitation generally occurs as snow from December through

February. Accumulations above 12 inches are not common but can occur. Snow usually lasts for 3 or 4 days but can persist much longer.

The elevation range for this Land Resource Unit is generally 4,500 to 6,000 feet. Big sagebrush is characteristic of many sites and can be dominant on some of them (fig. 14). Other shrubs include cliffrose, Mormon tea, fourwing saltbush, and blackbrush. Utah juniper and Colorado pinyon are scattered across many sites and can be numerous on the hills and shallow soils. Most sites will support an abundance of perennial grasses, such as blue grama, galleta, squirreltail, Indian ricegrass, and various needlegrasses. Perennial grasses can be dominant on a number of sites. Characteristic chaparral species, such as manzanita and turbinella oak are found on

some sites, usually in the steep transition zones at the higher elevations.

Land Resource Unit 35-5AZ—Grand Canyon River Corridor

Average annual precipitation for this Land Resource Unit ranges from 6 to 10 inches. Soil temperatures are classified as typically thermic. However, this Land

Resource Unit covers the extreme vertical elevation range of the Grand Canyon corridor and extremely strong differences in aspect over relatively short distances. Soils can be mesic at the upper elevations on the cooler aspects and hyperthermic at the lowest elevations on the warmer aspects. Summer daytime air temperatures often exceed 100 degrees F and can reach 120 degrees F at the lower elevations. Winter air temperatures routinely get as low as 15 degrees F in



Figure 14.—Wyoming sagebrush, cliffrose, scattered Utah juniper, and Whipple cholla are typical of the vegetation on Land Resource Unit 35-3AZ.

some areas, and have been recorded below 0 degrees F. Typical frost-free and freeze-free periods last from 180 to 320 days and from 210 to 340 days, respectively.

The elevation on this Land Resource Unit generally ranges from 1,600 to 4,500 feet. Vegetation in the riparian zones along the Colorado River and its tributaries includes various willows, arrowweed, and mesquite (fig. 15). Also present are common reeds and numerous rushes and sedges. Salt cedar, an introduced species, is now common in the riparian zones. Mormon tea, catclaw, white brittlebush, and various cactus species are characteristic of the sites that contain the hills, cliffs, and steep colluvial slopes. Big galleta, blue threeawn, and a wide variety of forbs are also common. The plant communities on these sites are strongly influenced by the presence or absence of eolian sand deposits on the soil surface.

They also reflect the extremes of very hot and relatively cool exposures. Many of the upland sites have a blackbrush component, and on some sites it is dominant. Certain upland sites at higher elevations will support a mixed grassland-shrub community.

Land Resource Unit 35-6AZ—Colorado Plateau Pinyon-Juniper-Sagebrush

Average annual precipitation for this Land Resource Unit ranges from 13 to 17 inches. Soil temperatures are classified as mesic. Summer daytime temperatures often range from 90 to 95 degrees F and can exceed 100 degrees F. Winter air temperatures below 10 degrees F are routine, and lows below -25 degrees F have been recorded. Typical frost-free and freeze-free periods range from 120 to 160 days and from 140 to 180 days, respectively. Precipitation generally occurs as snow from November into March.



Figure 15.—Beaches and riparian areas have very complex vegetative patterns. Here at Little Nankoweap the vegetation is dominated by sand dropseed, mesa dropseed, spike dropseed, prickly pear, and catclaw acacia. It is in Land Resource Unit 35-5AZ.

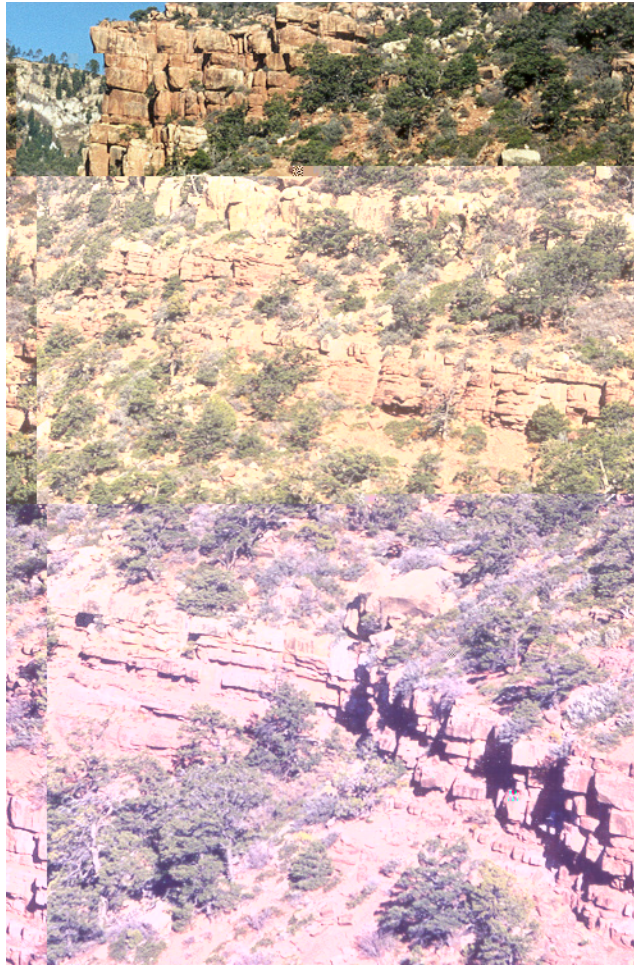


Figure 16.—Vegetation on the Nankoweap Trail just below Saddle Mountain in Land Resource Unit 35-6AZ.

Accumulations of more than 12 inches are fairly common and can persist for several weeks, especially on cooler, shaded slopes.

Elevations in this Land Resource Unit generally range from 5,500 to 7,000 feet (fig. 16). It often has an overstory of pinyon-juniper; many sites are classified as forestland that has the potential of achieving a tree canopy cover greater than 25 percent. Utah juniper and Colorado pinyon are the dominant species. Singleleaf pinyon, Rocky Mountain juniper, and ponderosa pine can be present. Gambel oak can sometimes be found in tree form, although it is usually present as a shrub. Other shrubs, such as big sagebrush, cliffrose, and Mormon tea, also populate the shrub understory. Perennial grasses include muttongrass, prairie junegrass, squirreltail, western wheatgrass, and blue grama. Some sites in this land resource unit, especially those where soils are deep, are a shrub-grassland community with scattered trees. Chaparral species, such as turbinella oak, manzanita, littleleaf

mountain mahogany, and silktassel, are sometimes plentiful in the steep transition zones.

Land Resource Unit 35-8AZ—Colorado Plateau Ponderosa Forests

Average annual precipitation for this Land Resource Unit ranges from 17 to 25 inches. Soil temperatures are classified as mesic. Summer daytime temperatures typically range from 80 to 90 degrees F, but they can exceed 95 degrees F. Winter temperatures around 0 degrees F are common, but they can fall as low as -25 degrees F. Typical frost-free and freeze-free periods range from 80 to 130 days and from 105 to 150 days, respectively. Precipitation generally occurs as snow from October into April. Snowpack can persist for 3-4 months, although it may disappear in exposed areas during prolonged dry weather.

The elevation range for this Land Resource Unit is generally 6,800-8,500 feet. Ponderosa pine dominates most sites (fig. 17). White fir and aspen can be found in some areas, and pinyon and juniper are often present on the warmer exposures. Gambel oak is frequently present in tree form and occasionally as a shrub. A scattered shrub understory includes big sagebrush, ceanothus, and blue elderberry. Under a heavy tree canopy, the herbaceous understory is limited to shade-tolerant perennial grasses, such as muttongrass, upland sedge, and big wildrye, and to forbs such as lotus and wood betony. In areas of an open canopy or clearings in the forest, a diverse grass-forb understory with scattered shrubs is present, and perennial grass species include mountain muhly, Arizona fescue, pine dropseed, and blue grama. Many species of annual and perennial forbs are present.

Land Resource Unit 35-9AZ—Colorado Plateau Mixed-Conifer Forests

Average annual precipitation for this Land Resource Unit ranges from 25 to 33 inches. Soil temperatures are classified as frigid. Summer daytime temperatures typically range from 70 to 80 degrees F and rarely exceed 90 degrees F. Winter air temperatures below 0 degrees F are common and can fall below -30 degrees F. Typical frost-free and freeze-free periods range from 70 to 105 days and from 85 to 130 days, respectively. Precipitation occurs as snow from October through April. Snowpack can persist as long as 8 months in some areas and can accumulate to a considerable depth (8 to 12 feet) during wet years.

The elevation range for this Land Resource Unit is generally 8,000-9,700 feet. White fir, ponderosa pine, and quaking aspen are the dominant species on some



Figure 17.—Ponderosa pine forests are typical on Land Resource Unit 35-8AZ.

forest sites (fig. 18). Other, generally cooler, sites have dense stands of Engelmann spruce and subalpine fir mixed with aspen. Douglas fir can be present in both forest communities and is occasionally abundant. Blue spruce is occasionally found along the edge of cold-air drainages. Under a dense tree canopy, the herbaceous understory is a very sparse mixture of species, such as muttongrass, upland sedge, big wildrye, redroot buckwheat, creeping mahonia, and dwarf juniper.

Clearings and deep upland soils support numerous grass species, including mat muhly, mountain muhly, various fescues and needlegrasses, and alpine timothy. These open areas also have a rich diversity of annual and perennial forbs, or wildflowers. Bottom sites are generally confined to drainages and sinks. They contain wetter-loving species, such as tufted hairgrass, bentgrass, and several types of rushes and sedges.



Figure 18.—Engelmann and blue spruce near The Basin on the Kaibab Plateau in Land Resource Unit 35-9AZ.

How This Survey Was Made

This survey was made to provide information about the soils and miscellaneous areas in the survey area. The information includes a description of the soils and miscellaneous areas and their location and a discussion of their suitability, limitations, and management for specified uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils and miscellaneous areas in the survey area are in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform (fig. 19). By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept or model of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind

of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the

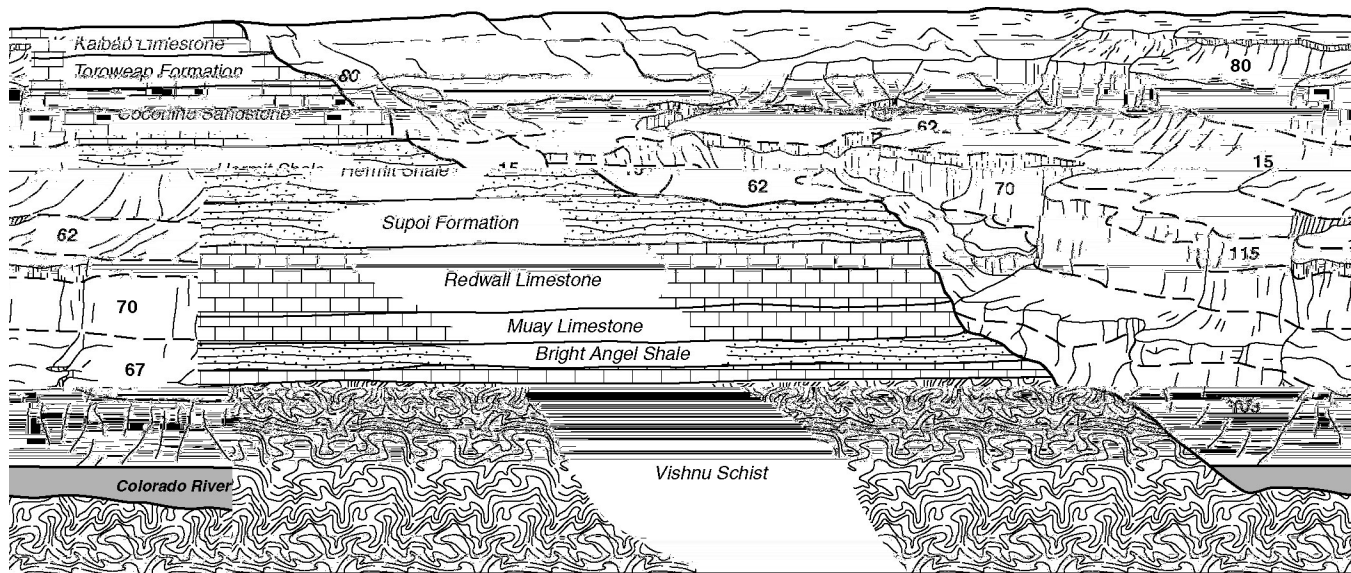


Fig. 19.—Typical pattern of soil map units, landforms, and lithologies in the western Grand Canyon.

same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain

depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

In order to make mapping the soils of the Grand Canyon a feasible task, the canyon was organized into several divisions based on large-scale geologic and physiographic features. These consisted of the six plateaus comprising the rim, the canyon interior, the inner gorge, and the river corridor. It was also necessary to prioritize which areas needed more detail and which ones needed less. The South Rim was designated as a high priority area because of high intensity land use and easy public access. The North Rim was also designated as a high use area along with the Bright Angel Corridor. These areas have been mapped in more detail and with a greater degree of documentation. Very limited access in the interior of the canyon required that available vegetation (USDI, 1982) and geologic maps (Huntoon and Billingsly, 1986) be used for remote sensing many areas that have been ground-truthed as opportunity permitted.

Detailed Soil Map Units

The map units delineated on the soil maps in this survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this section, along with the maps, can be used to determine the suitability and potential of a unit for specific uses. They also can be used to plan the management needed for those uses.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently map units may contain the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Many minor components have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. The minor components that are contrasting or significantly dissimilar are mentioned in the map unit descriptions. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape. Map units in the canyon interior do not list minor components because inaccessibility prevented documenting them.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Some map units are made up of two or more major soil components or miscellaneous areas. These map units are complexes, associations, consociations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. The Kanabownits-Kippers-Kaiparowits complex, 2 to 15 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. The Yumtheska-Bilburc association, 10 to 45 percent slopes, is an example.

A *consociation* is made up of one dominant soil that is shown as one unit on the maps. At least one half of the soils in each delineation of a soil

consociation are the same soil components that provide the name for the map unit. Huevi extremely gravelly fine sandy loam, 2 to 4 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Typic Torriorthents soils and Badlands, Chuar Group, 15 to 65 percent slopes, is an undifferentiated group in this survey area.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Table 1 gives the acreage and proportionate extent of each map unit. Other tables give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils or miscellaneous areas.

1—Albers clay loam, 0 to 1 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,900 to 6,100 feet (1,798 to 1,859 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)

Mean annual soil temperature: 50 to 54 degrees F (10 to 12 degrees C)

Frost-free period: 135 to 150 days

Map Unit Composition

Albers and similar soils: 90 percent

Minor components: 10 percent soils that are poorly or very poorly drained

Properties and Qualities

Albers soils

Taxonomic classification: Fine, smectitic, mesic Aridic Haplusterts

Geomorphic position: concavities and broad drainageways

Parent material: alluvium derived from basalt

Slope: 0 to 1 percent

Drainage class: Well drained

Permeability: about 0.03 in/hr (very slow)

Available water capacity total inches: 9.2

Shrink-swell potential: about 12.0 LEP (very high)

Flooding hazard: Occasional ponding

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Negligible

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Clayey Upland 13-17" p.z.

Ecosystem site number: 035XF604AZ

Present native vegetation: Western wheatgrass, Wyoming big sagebrush, bottlebrush squirreltail, blue grama, Chrysothamnus

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Shivwits Plateau; 1.24 miles northeast of Pine Valley; 36 degrees, 7 minutes, 3 seconds north latitude; 113 degrees, 25 minutes, 56 seconds west longitude.

A—0 to 1 inch; brown (7.5YR 4/3) silt clay loam that has a 5-millimeter-thick silt crust; very dark brown (7.5YR 2.5/3) moist; strong fine granular structure; soft, very friable, moderately sticky and moderately plastic; common very fine and few fine and medium irregular pores; noneffervescent, neutral (pH 7.0); abrupt smooth boundary.

Btss1—1 to 8 inches; brown (7.5YR 4/3) silty clay loam; very dark brown (7.5YR 2.5/3) moist; weak and moderate coarse prismatic structure parting to moderate coarse angular blocky; hard, friable, very sticky and very plastic; few very fine and fine roots; common very fine and fine and few medium tubular pores; many distinct clay films lining pores; many pressure faces and few slickensides; cracks between peds are filled with massive silty clay loam; noneffervescent, neutral (pH 7.0); clear wavy boundary.

Btss2—8 to 32 inches; brown (7.5YR 4/3) silty clay; very dark brown (7.5YR 2.5/3) moist; moderate very coarse prismatic structure parting to moderate coarse angular blocky; very hard, firm, very sticky and very plastic; few very fine and fine roots mainly occurring between peds; common very fine through coarse tubular and few very fine irregular pores; continuous distinct clay films lining pores; many pressure faces and few slickensides; 1- to 5-millimeter-thick vertical cracks approximately 3 inches apart; few slightly hard masses of carbon; noneffervescent, neutral (pH 7.0); clear wavy boundary.

Btss3—32 to 60 inches; brown (7.5YR 4/3) clay; very

dark brown (7.5YR 2.5/3) moist; strong very coarse prismatic structure parting to strong coarse angular blocky; very hard, firm, very sticky and very plastic; few very fine through coarse roots mainly occurring between peds; many very fine irregular and few very fine tubular pores; many pressure faces and common slickensides; 2- to 10-millimeter-thick vertical cracks approximately 4 inches apart; few slightly hard masses of carbon; noneffervescent; slightly alkaline (pH 7.6).

Range in Characteristics

Clay content: averages 40 to 55 percent in the particle size control section

Cracking: deep, wide cracks are open more than 210 days cumulative

A horizon

Hue: 7.5YR, 10YR

Value: 2 through 5, dry or moist

Chroma: 2 through 4, dry or moist

Btss horizons

Hue: 7.5YR, 10YR

Value: 2.5 through 5, dry or moist

Chroma: 2 or 3, dry or moist

Reaction: neutral to slightly alkaline

Calcium carbonate equivalent: 0 to 15 percent below 30 inches

Rock fragments: less than 5 percent

Slickensides: common to many, becoming less common with depth

2—Argic Petrocalcids, 8 to 15 percent slopes

Map Unit Setting

Landform: fan terrace

Elevation: 3,500 to 4,500 feet (1,067 to 1,372 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 200 to 240 days

Map Unit Composition

Argic Petrocalcids and similar soils: 100 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major

components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Argic Petrocalcids soils

Taxonomic classification: Argic Petrocalcids

Geomorphic position: summits of fan terraces

Parent material: alluvium derived from mixed sources

Slope: 8 to 15 percent

Depth to restrictive feature: 9 to 20 inches to petrocalcic

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Upland, Shallow 6-10" p.z.

Ecosystem site number: 035XE519AZ

Present native vegetation: blackbrush, ephedra, Opuntia, banana yucca

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In Chuar Valley; 1,353 feet northeast of Chuar Creek; 36 degrees, 9 minutes, 44 seconds north latitude; 111 degrees, 51 minutes, 37 seconds west longitude.

A—0 to 2 inches; brown (7.5YR 5/4) very gravelly sandy clay loam; brown (7.5YR 4/4) moist; moderate thin platy structure; slightly hard, very friable, slightly sticky and moderately plastic; few very fine roots; many very fine vesicular pores; 30 percent gravel, 10 percent cobble, and 5 percent stone; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Btk1—2 to 10 inches; strong brown (7.5YR 4/6) very gravelly sandy clay loam; strong brown (7.5YR 4/6) moist; strong fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and moderately plastic; many very fine and common fine through coarse roots; common fine through coarse tubular pores; common distinct clay films on faces of peds and lining pores; common fine and medium soft calcium carbonate masses; common moderately thick calcium carbonate coats and pendants on the undersides of rock fragments; 30 percent gravel, 5 percent cobble; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Btk2—10 to 16 inches; yellowish red (5YR 4/6) very gravelly clay loam; yellowish red (5YR 4/6) moist; moderate fine and medium subangular blocky

structure; hard, very friable, moderately sticky and moderately plastic; many very fine and fine and common medium roots; common fine through coarse tubular pores; common distinct clay films on faces of peds; many fine and medium slightly hard calcium carbonate masses; many thick calcium carbonate coats and pendants on the undersides and sides of rock fragments; 30 percent gravel, 10 percent cobble; violently effervescent, moderately alkaline (pH 8.4); abrupt irregular boundary.

Bkm—16 to 52 inches; indurated petrocalcic horizon; clear wavy boundary.

C—52 to 60 inches; reddish brown (5YR 5/4) very gravelly sandy loam; reddish brown (5YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; 35 percent gravel, 10 percent cobble, and 10 percent stone; violently effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

3—Argic Petrocalcids, warm, 2 to 30 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,500 to 5,000 feet (1,372 to 1,524 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 200 to 240 days

Map Unit Composition

Argic Petrocalcids and similar soils: 100 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Argic Petrocalcids soils

Taxonomic classification: Argic Petrocalcids

Geomorphic position: depressions in basalt flows

Parent material: residuum weathered from basalt

Slope: 2 to 30 percent

Depth to restrictive feature: 6 to 20 inches to petrocalcic; 11 to 26 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Basalt Hills 6-10" p.z.

Ecosystem site number: 035XE501AZ

Present native vegetation: ephedra, catclaw acacia, blue threeawn, rayless brittlebush, Ferocactus

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In Toroweap Valley; 36 degrees, 13 minutes, 6 seconds north latitude; 113 degrees, 5 minutes, 56 seconds west longitude.

A—0 to 3 inches; light brown (7.5YR 6/3) very gravelly loam; brown (7.5YR 4/4) moist; moderate thin platy structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine vesicular and tubular pores; 30 percent gravel, 10 percent cobble; slightly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

Bt—3 to 8 inches; light brown (7.5YR 6/4) gravelly loam; brown (7.5YR 4/4) moist; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and moderately plastic; common very fine and few fine roots; common very fine and few fine tubular pores; common faint clay films bridging sand grains and lining pores; 20 percent gravel, 10 percent cobble; strongly effervescent; moderately alkaline (pH 8.2); gradual smooth boundary.

Btk—8 to 17 inches; light brown (7.5YR 6/4) gravelly loam; brown (7.5YR 4/4) moist; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and moderately plastic; common very fine and few fine roots; common very fine and fine tubular pores; common faint clay films bridging sand grains and lining pores; few faint clay films on faces of peds; 20 percent gravel, 10 percent cobble; common medium soft seams and masses of calcium carbonate; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bkm—17 to 25 inches; indurated petrocalcic horizon.

R—25 inches; basalt bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given, and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

4—Aridic Haplustalfs-Lithic Haplustalfs complex, 2 to 30 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,000 to 7,500 feet (1,524 to 2,286 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)

Mean annual soil temperature: 50 to 54 degrees F (11 to 13 degrees C)

Frost-free period: 135 to 150 days

Map Unit Composition

Aridic Haplustalfs and similar soils: 55 percent

Lithic Haplustalfs and similar soils: 45 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Aridic Haplustalfs soils

Taxonomic classification: Aridic Haplustalfs

Geomorphic position: pockets and ledges of basalt flows

Parent material: residuum weathered from basalt

Slope: 2 to 30 percent

Depth to restrictive feature: 20 to 60 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Clay Loam Upland, Gravelly (PIED, JUOS) 13-17" p.z.

Ecosystem site number: 035XF611AZ

Present native vegetation: muttongrass, Utah juniper, Wyoming big sagebrush, blue grama, Colorado pinyon

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In the Uinkaret Mountains; 2,943 feet southwest of The Cove; 36 degrees, 14 minutes, 1 second north latitude; 113 degrees, 8 minutes, 54 seconds west longitude.

A—0 to 2 inches; yellowish brown (10YR 5/4) very gravelly loam; dark yellowish brown (10YR 3/4) moist; weak thin platy structure parting to moderate very fine subangular blocky; soft, very friable, nonsticky and nonplastic; few very fine roots; many very fine and few fine and medium vesicular pores; 25 percent gravel, 10 percent cobble; noneffervescent; slightly alkaline (pH 7.4); abrupt smooth boundary.

Bt1—2 to 5 inches; brown (7.5YR 4/3) loam; dark brown (7.5YR 3/3) moist; moderate medium subangular blocky structure; hard, friable, slightly sticky and moderately plastic; common very fine and few fine and medium roots; common very fine and few fine tubular pores; common faint clay films bridging sand grains and lining pores; 10 percent gravel; noneffervescent; neutral (pH 7.2); abrupt smooth boundary.

Bt2—5 to 10 inches; brown (7.5YR 4/3) loam; dark brown (7.5YR 3/4) moist; moderate fine and medium subangular blocky structure; hard, friable, moderately sticky and moderately plastic; common very fine and few medium and coarse roots; common very fine and few fine tubular pores; common faint clay films on faces of peds and lining pores; 10 percent gravel; noneffervescent; slightly alkaline (pH 7.4); clear smooth boundary.

Bt3—10 to 14 inches; brown (7.5YR 5/4) gravelly clay loam; dark brown (7.5YR 3/4) moist; moderate fine and medium subangular blocky structure; hard, friable, moderately sticky and moderately plastic; few very fine through coarse roots; common very fine and few fine tubular pores; common faint clay films on faces of peds and lining pores; 15 percent gravel, 5 percent cobble; noneffervescent; neutral (pH 7.2); gradual smooth boundary.

Bt4—14 to 19 inches; brown (7.5YR 5/4) extremely gravelly loam; brown (7.5YR 4/4) moist; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and moderately plastic; few very fine

through coarse roots; common very fine and few fine tubular pores; common thin clay films lining pores and few faint clay films on faces of peds; moderately thick coats and pendants of calcium carbonate on rock fragments; 50 percent gravel, 10 percent cobble; noneffervescent; slightly alkaline (pH 7.6); gradual wavy boundary.

C—19 to 23 inches; brown (7.5YR 5/4) extremely gravelly loam; brown (7.5YR 4/4) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and moderately plastic; few very fine through coarse roots; few very fine and fine tubular pores; moderately thick coats and pendants of calcium carbonate on rock fragments; 60 percent gravel, 20 percent cobble; noneffervescent; slightly alkaline (pH 7.8); abrupt wavy boundary.

R—23 inches; fractured basalt bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Lithic Haplustalfs soils

Taxonomic classification: Lithic Haplustalfs

Geomorphic position: pockets and ledges of basalt flows

Parent material: residuum weathered from basalt

Slope: 2 to 30 percent

Depth to restrictive feature: 7 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Basalt Upland (JUOS) 13-17" p.z.

Ecosystem site number: 035XF620AZ

Present native vegetation: Utah juniper, muttongrass, Colorado pinyon, Stansbury cliffrose, bottlebrush squirreltail, turbinella oak

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In the Uinkaret Mountains; 1.94 miles east of Mount Emma; 36 degrees, 15 minutes, 57

seconds north latitude; 113 degrees, 8 minutes, 11 seconds west longitude.

A—0 to 2 inches; pale brown (10YR 6/3) very gravelly loam; dark brown (10YR 3/3) moist; moderate thin platy structure parting to moderate very fine and fine subangular blocky; soft, very friable, slightly sticky and slightly plastic; common very fine roots; common very fine and few fine vesicular and common fine tubular pores; 25 percent gravel, 5 percent cobble, and 5 percent stone; noneffervescent; neutral (pH 7.2); abrupt smooth boundary.

Bt1—2 to 8 inches; brown (10YR 5/3) gravelly loam; dark brown (10YR 3/3) moist; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and moderately plastic; common very fine and few fine and medium roots; common very fine and few fine tubular pores; common faint clay films on faces of peds and lining pores; 20 percent gravel, 5 percent cobble; noneffervescent; neutral (pH 7.2); clear smooth boundary.

Bt2—8 to 14 inches; pale brown (10YR 6/3) very cobbly loam; brown (10YR 4/3) moist; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and moderately plastic; few very fine through coarse roots; common very fine and few fine tubular pores; many faint clay films lining pores and few faint clay films on faces of peds; 20 percent gravel, 15 percent cobble; noneffervescent; neutral (pH 7.2); gradual smooth boundary.

Bt3—14 to 18 inches; light yellowish brown (10YR 6/4) very cobbly loam; dark yellowish brown (10YR 4/4) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and moderately plastic; few fine through coarse roots; common very fine and few fine tubular pores; common faint clay films lining pores and few faint clay films on faces of peds; 20 percent gravel, 20 percent cobble, and 5 percent stone; noneffervescent; neutral (pH 7.2); abrupt wavy boundary.

R—18 inches; fractured, slightly weathered basalt bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given, and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

5—Aridic Haplustepts, 0 to 8 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,000 to 7,000 feet (1,524 to 2,134 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)

Mean annual soil temperature: 50 to 54 degrees F (11 to 13 degrees C)

Frost-free period: 135 to 150 days

Map Unit Composition

Aridic Haplustepts and similar soils: 100 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Aridic Haplustepts soils

Taxonomic classification: Aridic Haplustepts

Geomorphic position: alluvial basins between basalt flows

Parent material: alluvium

Slope: 0 to 8 percent

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Loamy Upland 13-17" p.z.

Ecosystem site number: 035XF605AZ

Present native vegetation: Wyoming big sagebrush, blue grama, muttongrass, western wheatgrass, other evergreen trees

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In Toroweap Valley; 36 degrees, 13 minutes, 20 seconds north latitude; 113 degrees, 6 minutes, 48 seconds west longitude.

A—0 to 2 inches; yellowish brown (10YR 5/4) gravelly loam; dark yellowish brown (10YR 4/4) moist; moderate thin platy structure; soft, very friable, nonsticky and slightly plastic; common very fine roots; many very fine vesicular and common very fine tubular pores; 20

percent gravel; strongly effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

AB—2 to 6 inches; yellowish brown (10YR 4/4) loam; dark yellowish brown (10YR 4/4) moist; weak thin platy structure parting to weak fine subangular blocky; slightly hard, friable, nonsticky and slightly plastic; common very fine and few fine roots; common very fine and few fine tubular pores; 10 percent gravel; strongly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bw1—6 to 19 inches; yellowish brown (10YR 5/4) loam; dark yellowish brown (10YR 4/4) moist; moderate fine and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; common very fine and few fine tubular pores; 10 percent gravel; violently effervescent; strongly alkaline (pH 8.6); gradual smooth boundary.

Bw2—19 to 26 inches; light yellowish brown (10YR 6/4) loam; dark yellowish brown (10YR 4/4) moist; weak fine and medium subangular blocky structure; hard, friable, nonsticky and nonplastic; few very fine and fine roots; common very fine and fine tubular pores; 5 percent gravel; violently effervescent; strongly alkaline (pH 8.6); gradual smooth boundary.

C—26 to 60 inches; light yellowish brown (10YR 6/4) loam; dark yellowish brown (10YR 4/4) moist; weak fine and medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few very fine and fine roots; common very fine and few fine tubular pores; 5 percent gravel; violently effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given, and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

6—Aridic Lithic Ustorthents-Rock outcrop complex, Supai Group, cool, 15 to 55 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 7,000 to 7,990 feet (2,134 to 2,436 meters)
Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)

Mean annual soil temperature: 50 to 54 degrees F (11 to 13 degrees C)

Frost-free period: 120 to 160 days

Map Unit Composition

Aridic Lithic Ustorthents and similar soils: 70 percent
 Rock outcrop: 30 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Aridic Lithic Ustorthents soils

Taxonomic classification: Aridic Lithic Ustorthents

Geomorphic position: pockets and ledges of canyon sidewalls

Parent material: colluvium derived from sandstone

Slope: 15 to 55 percent

Depth to restrictive feature: 8 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Sedimentary Cliffs 13-17" p.z.

Ecosystem site number: 035XF601AZ

Present native vegetation: littleleaf mountain-mahogany, turbinella oak, other evergreen trees, pointleaf manzanita, desert needlegrass

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In Chuar Valley; 1,963 feet south of Saddle Mountain; 36 degrees, 18 minutes, 25 seconds north latitude; 111 degrees, 56 minutes, 55 seconds west longitude.

A—0 to 2 inches; red (2.5YR 4/6) extremely cobbly loam; dark red (2.5YR 3/6) moist; weak fine subangular blocky structure; soft, very friable, moderately sticky and moderately plastic; common fine and medium and few coarse roots; many very fine irregular and common fine tubular pores; 25 percent gravel, 30 percent cobble, 5 percent stone, and 5 percent boulder;

strongly effervescent; strongly alkaline (pH 8.6); abrupt smooth boundary.

Bw—2 to 8 inches; red (2.5YR 4/6) extremely cobbly loam; dark red (2.5YR 3/6) moist; weak medium subangular blocky structure; soft, very friable, moderately sticky and moderately plastic; common fine and medium and few coarse roots; common fine through coarse tubular pores; 25 percent channers, 10 percent gravel, 30 percent cobble, 5 percent stone, and 5 percent boulder; strongly effervescent; strongly alkaline (pH 8.6); clear wavy boundary.

Crk—8 to 16 inches; partially weathered sandstone with calcium carbonate in cracks.

R—16 inches; hard sandstone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Rock outcrop

Sandstone and mudstone of the Supai Group on ledges and outcrops of canyon sidewalls.

7—Arizo very gravelly sandy loam, 1 to 5 percent slopes

Map Unit Setting

Landform: flood plain

Elevation: 1,800 to 3,000 feet (548 to 914 meters)

Mean annual precipitation: 6 to 9 inches (152 to 229 millimeters)

Mean annual air temperature: 64 to 68 degrees F (18 to 20 degrees C)

Mean annual soil temperature: 66 to 71 degrees F (20 to 22 degrees C)

Frost-free period: 230 to 280 days

Map Unit Composition

Arizo and similar soils: 75 percent

Minor components: 25 percent

- Deep, very gravelly, loamy, calcareous soils on summits
- Soils that are not flooded

- Soils that have a stony or very stony surface phase

Properties and Qualities

Arizo soils

Taxonomic classification: sandy-skeletal, mixed, thermic Typic Torriorthents
Geomorphic position: flood plains
Parent material: alluvium
Slope: 1 to 5 percent
Surface fragments: about 55 percent coarse gravel, about 25 percent cobbles, about 10 percent stones
Drainage class: Somewhat excessively drained
Permeability: about 1.28 in/hr (moderate)
Available water capacity total inches: 1.5
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: Occasional
Seasonal water table minimum depth: greater than 6 feet
Runoff class: Low
Hydrologic group: A
Major Land Resource Area: 30
Land Resource Unit: 30-2
Ecological site name: Sandy Wash 6-9" p.z.
Ecosystem site number: 030XB218AZ
Present native vegetation: white burrobrush, creosotebush, catclaw acacia, big galleta
Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 1.61 miles south of Gyp Hills; 36 degrees, 16 minutes, 50 seconds north latitude; 113 degrees, 54 minutes, 20 seconds west longitude.

A—0 to 1 inch; reddish yellow (7.5YR 6/6) very gravelly sandy loam, brown (7.5YR 4/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and few medium roots; few very fine tubular and common very fine irregular pores; 45 percent gravel; violently effervescent; moderately alkaline (pH 8.4); abrupt wavy boundary.

C—1 to 60 inches; reddish yellow (7.5YR 6/6) stratified extremely stony coarse sand to extremely gravelly loamy sand, strong brown (7.5YR 4/6) moist; single grain; loose, slightly sticky and slightly plastic; common very fine and fine roots; few very fine and fine tubular pores; 45 percent gravel, 15 percent cobble, 10 percent stone; strongly effervescent; moderately alkaline (pH 8.2).

Range in Characteristics

Rock fragments: 35 to 85 percent in the particle size control section

A horizon

Hue: 7.5YR, 10YR
 Value: 6 or 7 dry, 4 through 6 moist
 Chroma: 4 through 6, dry or moist

C horizons

Hue: 7.5YR, 10YR
 Value: 6 or 7 dry, 4 through 6 moist
 Chroma: 4 through 6, dry or moist
 Calcium carbonate equivalent: less than 10 percent

8—Bilburc very gravelly loam, 2 to 6 percent slopes

Map Unit Setting

Landform: plateau
Elevation: 5,900 to 6,100 feet (1,798 to 1,860 meters)
Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)
Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)
Mean annual soil temperature: 50 to 54 degrees F (11 to 13 degrees C)
Frost-free period: 135 to 150 days

Map Unit Composition

Bilburc and similar soils: 85 percent
 Minor components: 15 percent

- Yumtheska soils
- Soils that have steeper slopes
- Soils in drainageways that are subject to frequent flooding
- Soils that have an extremely gravelly surface phase
- Soils that do not have calcium carbonate accumulations in the profile

Properties and Qualities

Bilburc soils

Taxonomic classification: Fine, smectitic, mesic Vertic Paleustolls
Geomorphic position: summits
Parent material: residuum weathered from cherty limestone
Slope: 2 to 6 percent

Surface fragments: about 40 percent coarse gravel
Depth to restrictive feature: 23 to 39 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.03 in/hr (very slow)

Available water capacity total inches: 4.9

Shrink-swell potential: about 9.0 LEP (very high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Clay Loam Upland, Gravelly (PIED, JUOS) 13-17" p.z.

Ecosystem site number: 035XF611AZ

Present native vegetation: muttongrass, Utah juniper, Wyoming big sagebrush, blue grama, Colorado pinyon

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Shivwits Plateau; 1.99 miles southwest of Mathis Spring; 36 degrees, 4 minutes, 59 second north latitude; 113 degrees, 37 minutes, 48 seconds west longitude.

A1—0 to 1 inch; brown (7.5YR 4/3) very gravelly loam, dark brown (10YR 3/3) moist; weak fine granular structure; soft, very friable, moderately sticky and moderately plastic; common fine roots; many very fine tubular pores; noneffervescent; 40 percent gravel; neutral (pH 7.0); abrupt smooth boundary.

A2—1 to 4 inches; dark brown (7.5YR 3/3) loam, dark brown (7.5YR 3/2) moist; moderate medium subangular blocky structure; soft, very friable, moderately sticky and moderately plastic; many very fine and fine roots; many very fine and fine and few medium tubular pores; noneffervescent; 5 percent gravel; neutral (pH 7.0); clear wavy boundary.

Bt—4 to 11 inches; dark brown (7.5YR 3/3) clay, dark brown (7.5YR 3/2) moist, strong fine angular blocky structure; hard, firm, very sticky and very plastic; common very fine through coarse roots; many very fine through coarse tubular pores; common faint clay films on faces of peds; slightly effervescent; 5 percent gravel; slightly alkaline (pH 7.4); clear wavy boundary.

Btkss1—11 to 17 inches; reddish brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; strong medium prismatic structure parting to strong medium angular blocky; very hard, very firm, very sticky and very plastic; few medium and coarse roots; few

medium and coarse tubular pores; many slickensides; many distinct clay films on faces of peds; strongly effervescent; 5 percent gravel; moderately alkaline (pH 8.2); clear wavy boundary.

Btkss2—17 to 26 inches; reddish brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) moist; strong coarse prismatic structure parting to strong medium angular blocky; very hard, very firm, very sticky and very plastic; few medium and coarse roots; few fine and medium tubular pores; many slickensides; many distinct clay films on faces of peds; few cracks between peds; common fine soft masses of calcium carbonate; strongly effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

Btk—26 to 36 inches; reddish brown (5YR 5/4) clay loam, reddish brown (5YR 5/4) moist; massive; hard, friable, very sticky and very plastic; few coarse roots; few coarse tubular pores; common faint clay films on faces of peds; many coarse soft masses of calcium carbonate; 10 percent calcium carbonate coated gravel; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

R—36 inches; limestone bedrock.

Range in Characteristics

Depth to bedrock: 20 to 40 inches

Rock fragments: average less than 15 percent in the particle size control section

Clay content: averages 35 to 55 percent in the particle size control section

A horizons

Hue: 7.5YR, 10YR

Value: 3 through 5 dry, 3 or 4 moist

Chroma: 2 or 3, dry or moist

The mollic horizon may include the upper part of the argillic horizon.

Bt and Btkss horizons

Hue: 5YR, 7.5YR

Value: 3 through 5 dry, 2 through 4 moist

Chroma: 2 through 4, dry or moist

Texture: clay, clay loam

Slickensides: few to many may occur in both or either the Bt or Btk horizons

Cracking: cracks 5 mm or more wide are present within 125 cm of the surface in most years.

Btk horizons

Hue: 2.5YR, 5YR, 7.5YR

Value: 4 through 6, dry or moist

Chroma: 2 through 6, dry or moist

Calcium carbonate equivalent: averages 15 to 40 percent

Some pedons may have Bk horizons in the lower part of the profile.

9—Binsin-Bilburc-Yumtheska complex, 2 to 15 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 6,200 to 6,800 feet (1,585 to 2,073 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)

Mean annual soil temperature: 50 to 54 degrees F (11 to 13 degrees C)

Frost-free period: 135 to 150 days

Map Unit Composition

Binsin and similar soils: 50 percent

Bilburc and similar soils: 20 percent

Yumtheska and similar soils: 15 percent

Minor components: 15 percent

- Soils that have more than 35 percent by volume rock fragments in the profile
- Soils that have steeper slopes
- Soils in drainageways that are subject to occasional flooding
- Soils that have less organic matter in the profile
- Soils that have an extremely cobbly surface phase
- Soils that have a petrocalcic horizon above the bedrock
- Soils that do not have accumulations of calcium carbonate in the profile and are slightly acid throughout

Properties and Qualities

Binsin soils

Taxonomic classification: Fine, smectitic, mesic Vertic Paleustolls

Geomorphic position: summits of plateaus and mesas

Parent material: residuum weathered from cherty limestone

Slope: 2 to 15 percent

Surface fragments: about 70 percent coarse gravel

Drainage class:

163050, 163051, 163052, 163053, 163054, 163055, 163056, 163057, 163058, 163059, 163060, 163061, 163062, 163063, 163064, 163065, 163066, 163067, 163068, 163069, 163070, 163071, 163072, 163073, 163074, 163075, 163076, 163077, 163078, 163079, 163080, 163081, 163082, 163083, 163084, 163085, 163086, 163087, 163088, 163089, 163090, 163091, 163092, 163093, 163094, 163095, 163096, 163097, 163098, 163099, 163100, 163101, 163102, 163103, 163104, 163105, 163106, 163107, 163108, 163109, 163110, 163111, 163112, 163113, 163114, 163115, 163116, 163117, 163118, 163119, 163120, 163121, 163122, 163123, 163124, 163125, 163126, 163127, 163128, 163129, 163130, 163131, 163132, 163133, 163134, 163135, 163136, 163137, 163138, 163139, 163140, 163141, 163142, 163143, 163144, 163145, 163146, 163147, 163148, 163149, 163150, 163151, 163152, 163153, 163154, 163155, 163156, 163157, 163158, 163159, 163160, 163161, 163162, 163163, 163164, 163165, 163166, 163167, 163168, 163169, 163170, 163171, 163172, 163173, 163174, 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Btss2—19 to 28 inches; reddish brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; strong medium and coarse angular blocky structure; very hard, very firm, very sticky and very plastic; few fine and medium roots; few fine and medium tubular pores; many faint clay films on faces of peds; common slickensides; few cracks between peds; slightly effervescent; 5 percent gravel; neutral (pH 6.8); clear smooth boundary.

Btk1—28 to 35 inches; yellowish red (5YR 4/6) clay, reddish brown (5YR 4/4) moist; strong medium and coarse angular blocky structure; very hard, very firm, very sticky and very plastic; few fine and medium roots; few fine and medium tubular pores; many faint clay films on faces of peds; strongly effervescent; 5 percent gravel; moderately alkaline (pH 8.2); clear smooth boundary.

Btk2—35 to 45 inches; red (2.5YR 4/6) clay, red (2.5YR 4/6) moist; strong medium angular blocky structure; hard, firm, very sticky and very plastic; few fine roots; few fine tubular pores; common faint clay films lining pores, common medium soft masses of calcium carbonate and common thin calcium carbonate coats on the undersides of rock fragments; violently effervescent; 10 percent gravel; moderately alkaline (pH 8.4); clear smooth boundary.

Btk3—45 to 60 inches; reddish yellow (7.5YR 7/6) gravelly clay loam, yellowish red (5YR 5/6) moist; massive; hard, firm, very sticky and very plastic; few fine roots; few fine tubular pores; few faint clay films lining pores; calcium carbonate continuous throughout and strongly cemented in some areas; violently effervescent; 20 percent gravel; moderately alkaline (pH 8.4).

Range in Characteristics

Depth to bedrock: greater than 60 inches
 Rock fragments: average less than 15 percent in the particle size control section
 Clay content: averages 35 to 55 percent in the particle size control section
 Slickensides: few to many, may occur in both or either the Bt or Btk horizons
 Cracking: cracks 5 mm or more wide are present within 125 cm of the surface in most years.

A horizons

Hue: 7.5YR, 10YR
 Value: 4 or 5 dry, 2 or 3 moist; 2 through 4, dry or moist
 Chroma: 2 or 3, dry or moist

The mollic horizon may include the upper part of the argillic horizon.

Bt and Btss horizons

Hue: 5YR, 7.5YR
 Value: 4 or 5 dry, 2.5 or 3 moist
 Texture: clay, clay loam

Bk or Btk horizons

Hue: 2.5YR, 5YR, 7.5YR
 Value: 4 through 6, dry or moist
 Chroma: 2 through 6, dry or moist
 Texture: clay, clay loam, silty clay
 Calcium carbonate equivalent: averages 15 to 40 percent

Bilburc soils

Taxonomic classification: Fine, smectitic, mesic Vertic Paleustolls

Geomorphic position: summits and side slopes of low hills and ridges

Parent material: residuum weathered from cherty limestone

Slope: 2 to 15 percent

Surface fragments: about 50 percent coarse gravel

Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.03 in/hr (very slow)

Available water capacity total inches: 5.0

Shrink-swell potential: about 10.0 LEP (very high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Clay Loam Upland, Gravelly (PIED, JUOS) 13-17" p.z.

Ecosystem site number: 035XF611AZ

Present native vegetation: muttongrass, Utah juniper, Wyoming big sagebrush, blue grama, Colorado pinyon

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Shivwits Plateau; 1.10 miles southwest of Twin Spring; 36 degrees, 6 minutes, 6 seconds north latitude; 113 degrees, 36 minutes, 39 seconds west longitude.

A1—0 to 1 inch; dark brown (10YR 5/3) very gravelly loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; few very fine and fine tubular pores; 50 percent gravel;

noneffervescent; slightly acid (pH 6.2); abrupt smooth boundary.

A2—1 to 5 inches; brown (10YR 4/3) loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and fine and few medium roots; common fine tubular pores; 10 percent gravel; noneffervescent; slightly acid (pH 6.2); clear smooth boundary.

A3—5 to 11 inches; brown (7.5YR 4/3) loam, dark brown (7.5YR 3/3) moist; moderate medium subangular blocky structure; hard, friable, moderately sticky and moderately plastic; common very fine and fine and few medium and coarse roots; common fine tubular pores; 5 percent gravel; noneffervescent; slightly acid (pH 6.2); clear wavy boundary.

Bt—11 to 19 inches; reddish brown (5YR 4/4) clay, reddish brown (5YR 4/4) moist; strong medium angular blocky structure parting to strong fine angular blocky; hard, firm, very sticky and very plastic; few fine and medium roots; few fine tubular pores; 5 percent gravel; few faint clay films on faces of peds; noneffervescent; slightly acid (pH 6.4); clear wavy boundary.

Btss—19 to 24 inches; yellowish red (5YR 4/6) clay, yellowish red (5YR 4/6) moist; strong medium prismatic structure parting to strong fine and medium angular blocky; very hard, very firm, very sticky and very plastic; few fine and medium roots; few very fine tubular pores; common faint clay films on faces of peds; common slickensides; noneffervescent; slightly acid (pH 6.4); gradual wavy boundary.

Btk—24-30 inches; yellowish red (5YR 4/6) clay, yellowish red (5YR 4/6) moist; strong medium angular blocky structure; very hard, very firm, very sticky and very plastic; few fine and medium roots; few very fine tubular pores; 10 percent gravel; few faint clay films on faces of peds; common fine soft masses of calcium carbonate; violently effervescent; moderately alkaline (pH 8.0); abrupt irregular boundary.

R—30 inches; limestone bedrock.

Range in Characteristics

Depth to bedrock: 20 to 40 inches

Rock fragments: average less than 15 percent in the particle size control section

Clay content: averages 35 to 55 percent in the particle size control section

A horizons

Hue: 7.5YR, 10YR

Value: 4 or 5 dry, 3 or 4 moist

Chroma: 2 or 3, dry or moist

The mollic horizon may include the upper part of the argillic horizon.

Bt and Btss horizons

Hue: 5YR, 7.5YR

Value: 4 or 5 dry, 2 or 3 moist

Slickensides: few to many, may occur in both or either the Bt or Btk horizons

Cracking: cracks 5 mm or more wide are present within 125 cm of the surface in most years.

Bk or Btk horizons

Hue: 2.5YR, 5YR, 7.5YR

Value: 4 through 6, dry or moist

Chroma: 2 through 6, dry or moist

Calcium carbonate equivalent: averages 15 to 40 percent

Yumtheska soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Calciustolls

Geomorphic position: shoulders of low hills and ridges

Parent material: colluvium and/or residuum weathered from limestone and sandstone

Slope: 10 to 15 percent

Surface fragments: about 40 percent coarse gravel

Depth to restrictive feature: 11 to 19 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 2.1

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: High

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Limestone Slopes (PIED, JUOS) 13-17" p.z.

Ecosystem site number: 035XF613AZ

Present native vegetation: muttongrass, Artemisia, Stansbury cliffrose, Colorado pinyon, Utah juniper

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Shivwits Plateau; 1.09 miles west of Twin Spring; 36 degrees, 5 minutes, 35 seconds north latitude; 113 degrees, 36 minutes, 49 seconds west longitude.

A1—0 to 2 inches; brown (10YR 4/3) very gravelly

sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; 40 percent gravel; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

A2—2 to 7 inches; dark brown (10YR 3/3) gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine and medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine and common medium roots; many very fine and fine tubular pores; 30 percent gravel; violently effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bk1—7 to 11 inches; brown (10YR 4/3) very gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; massive; soft, very friable, slightly sticky and slightly plastic; many very fine and fine and common medium roots; many very fine and fine tubular pores; 55 percent gravel; many thick calcium carbonate coats and pendants on undersides of rock fragments; violently effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bk2—11 to 17 inches; light brown (7.5YR 6/3) very gravelly sandy loam, brown (7.5YR 5/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few fine tubular pores; calcium carbonate continuous throughout with common soft calcium carbonate bodies; 45 percent gravel; violently effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

R—17 inches; limestone bedrock.

Range in Characteristics

Rock fragments: average more than 35 percent in the particle size control section

Clay content: averages 18 to 20 percent in the particle size control section

Depth to bedrock: 11 to 19 inches

A horizon

Hue: 7.5YR, 10YR

Value: 3 through 5, dry or moist

Chroma: 2 through 4 dry, 2 or 3 moist

Organic matter: averages 1 to 5 percent in the surface

Bk horizon(s)

Hue: 7.5YR, 10YR

Value: 3 through 7 dry, 3 through 5 moist

Chroma: 2 through 4, dry or moist

Calcium carbonate equivalent: 15 to 40 percent

10—Bluepoint-Rock outcrop complex, 5 to 15 percent slopes

Map Unit Setting

Landform: valley floor

Elevation: 1,500 to 2,000 feet (457 to 610 meters)

Mean annual precipitation: 6 to 9 inches (152 to 229 millimeters)

Mean annual air temperature: 64 to 70 degrees F (18 to 21 degrees C)

Mean annual soil temperature: 66 to 72 degrees F (20 to 23 degrees C)

Frost-free period: 230 to 280 days

Map Unit Composition

Bluepoint and similar soils: 60 percent

Rock outcrop: 25 percent

Minor components: 15 percent

- Gypsil fine sandy loam, 5 to 15 percent slopes
- Meadview soils
- Orrubo very gravelly loam
- Arizo occasionally flooded
- Soils that are shallow or very shallow to sandstone bedrock
- Soils on steeper slopes

Properties and Qualities

Bluepoint soils

Taxonomic classification: Mixed, thermic Typic Torripsamments

Geomorphic position: sand dunes

Parent material: eolian deposits derived from sandstone

Slope: 5 to 15 percent

Drainage class: Somewhat excessively drained

Permeability: about 13 in/hr (rapid)

Available water capacity total inches: 4.2

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Low

Hydrologic group: B

Major Land Resource Area: 30

Land Resource Unit: 30-2

Ecological site name: Sandy Upland 6-9" p.z.

Ecosystem site number: 030XB221AZ

Present native vegetation: white bursage, sand dropseed, big galleta, Indian ricegrass, Nevada Mormon tea, Opuntia, creosotebush

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 2.54 miles northeast of Tassi Wash; 36 degrees, 13 minutes, 32 seconds north latitude; 113 degrees, 55 minutes, 26 seconds west longitude.

A—0 to 1 inch; pink (7.5YR 7/3) sand, brown (10YR 5/3) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; few fine and medium tubular pores; slightly effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

C1—1 to 3 inches; very pale brown (10YR 7/3) sand, brown (10YR 5/3) moist; single grain; loose, nonsticky and nonplastic; common very fine through medium roots; few fine and medium tubular pores; noneffervescent; moderately alkaline (pH 8.2); clear smooth boundary.

C2—3 to 30 inches; very pale brown (10YR 7/3) sand, brown (10YR 5/3) moist; single grain; loose, nonsticky and nonplastic; common very fine through medium roots; few fine and medium tubular pores; noneffervescent; moderately alkaline (pH 8.2); gradual smooth boundary.

C3—30 to 60 inches; very pale brown (10YR 7/3) sand, brown (10YR 5/3) moist; single grain; loose, nonsticky and nonplastic; few fine and medium roots; few fine and medium tubular pores; slightly effervescent; moderately alkaline (pH 8.2).

Range in Characteristics

Clay content: 2 to 5 percent in the particle size control section

Rock fragments: less than 5 percent in the particle size control section

Organic matter content: less than 0.5 percent

A and C horizons

Hue: 10YR, 7.5YR

Value: 4 through 7 dry, 3 through 6 moist

Chroma: 3 through 6, dry or moist

Rock outcrop

Flat ledges of sandstone

11—Bobzbulz extremely gravelly sandy loam, 2 to 10 percent slopes

Map Unit Setting

Landform: fan terrace

Elevation: 1,800 to 2,100 feet (548 to 640 meters)

Mean annual precipitation: 6 to 9 inches (152 to 229 millimeters)

Mean annual air temperature: 64 to 70 degrees F (18 to 21 degrees C)

Mean annual soil temperature: 66 to 72 degrees F (20 to 23 degrees C)

Frost-free period: 230 to 280 days

Map Unit Composition

Bobzbulz and similar soils: 90 percent

Minor components: 10 percent

- Arizo occasionally flooded
- Soils on toeslopes that are very deep to granitic conglomerate
- Bobzbulz extremely gravelly loam, 10 to 30 percent slopes

Properties and Qualities

Bobzbulz soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, thermic Typic Haplocambids

Geomorphic position: summits and side slopes of fan terraces

Parent material: colluvium and/or residuum weathered from noncalcareous conglomerate

Slope: 2 to 10 percent

Surface fragments: about 65 percent coarse gravel, about 10 percent cobbles, about 5 percent stones

Depth to restrictive feature: 22 to 32 inches to bedrock (paralithic)

Drainage class: Well drained

Permeability: about 0.40 in/hr (moderately slow)

Available water capacity total inches: 1.7

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: High

Hydrologic group: C

Major Land Resource Area: 30

Land Resource Unit: 30-2

Ecological site name: Limy Upland 6-9" p.z.

Ecosystem site number: 030XB214AZ

Present native vegetation: white bursage,
creosotebush, Nevada Mormon tea, white ratany,
winterfat

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 2.52 miles east of The Cockscomb; 36 degrees, 12 minutes, 55 seconds north latitude; 113 degrees, 55 minutes, 45 seconds west longitude.

A—0 to 3 inches; strong brown (7.5YR 5/6) extremely gravelly sandy loam, strong brown (7.5YR 4/6) moist; weak thin platy structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and common medium roots; many very fine and fine tubular pores; 50 percent gravel, 10 percent cobble, 5 percent stone; strongly effervescent; moderately alkaline (pH 8.0); clear smooth boundary.

Bw—3 to 14 inches; brown (7.5YR 5/4) very gravelly sandy clay loam, strong brown (7.5YR 4/6) moist; weak fine and medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine through coarse roots; common fine and medium tubular pores; 40 percent gravel, 5 percent cobble; strongly effervescent; moderately alkaline (pH 8.2); clear wavy boundary.

Bk—14 to 28 inches; light brown (7.5YR 6/4) extremely gravelly sandy clay loam, strong brown (7.5YR 4/6) moist; massive; slightly hard, very friable, moderately sticky and moderately plastic; few fine through coarse roots; few fine tubular pores; 65 percent gravel, 5 percent cobble; strongly effervescent; few coarse weathered granite clasts; moderately alkaline (pH 8.2); abrupt irregular boundary.

Cr—28-60 inches; weathered fanglomerate dominated by granite, schist and gneiss clasts.

Range in Characteristics

Parent material: colluvium and residuum from weathered granitic fanglomerate

Depth to paralithic contact: 22 to 32 inches

Clay content: averages 22 to 27 percent in the particle size control section

Rock fragments: average 60 to 80 percent, dominated by gravel, but there can be less than 60 percent in any one horizon

Organic matter content: 0.1 to 0.5 percent

A horizon

Hue: 7.5YR, 10YR

Value: 5 or 6 dry, 3 or 4 moist

Chroma: 3 through 6, dry or moist

Bw horizons

Hue: 7.5YR, 10YR

Value: 5 or 6 dry, 4 or 5 moist

Chroma: 3 through 6, dry or moist

Reaction: moderately alkaline to strongly alkaline

Effervescence: slightly effervescent through violently effervescent

Calcium carbonate equivalent: 1 to 10 percent

Calcium carbonate: is disseminated or occurs as thin coats on the underside of rock fragments

Bk horizon

Hue: 7.5YR, 10YR

Value: 6 or 7 dry, 4 or 5 moist

Chroma: 4 through 6, dry or moist

Reaction: moderately alkaline to strongly alkaline

Effervescence: strongly effervescent or violently effervescent

Calcium carbonate equivalent: 5 to 15 percent

Calcium carbonate: typically is disseminated or occurs as thin coats on the underside of rock fragments, weathered limestone clasts are present in some pedons.

Cr horizon

Consists of fanglomerate that is dominated by gravel and cobble-sized granite, schist and gneiss clasts with less than 5 percent limestone clasts. It is rigid through very rigid when dry, friable through extremely firm when moist. As much as 15 percent (air-dried) slakes when submerged in water.

12—Bobzbulz extremely gravelly sandy loam, 30 to 55 percent slopes

Map Unit Setting

Landform: fan terrace

Elevation: 1,500 to 2,500 feet (457 to 762 meters)

Mean annual precipitation: 6 to 9 inches (152 to 229 millimeters)

Mean annual air temperature: 64 to 70 degrees F (18 to 21 degrees C)

Mean annual soil temperature: 66 to 72 degrees F (20 to 23 degrees C)

Frost-free period: 230 to 280 days

Map Unit Composition

Bobzbulz and similar soils: 90 percent

Minor components: 10 percent

- Very deep soils in drainageways that are subject to occasional flooding

- Soils on toeslopes that are very deep
- Soils on steeper slopes

Properties and Qualities

Bobzbulz soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, thermic Typic Haplocambids

Geomorphic position: summits and sideslopes of fan terraces

Parent material: colluvium and/or residuum weathered from noncalcareous conglomerate

Slope: 30 to 55 percent

Surface fragments: about 55 percent coarse gravel, about 15 percent cobbles, about 5 percent stones

Depth to restrictive feature: 22 to 32 inches to bedrock (paralithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 1.7

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 30

Land Resource Unit: 30-2

Ecological site name: Limy Slopes 6-9" p.z.

Ecosystem site number: 030XB212AZ

Present native vegetation: white bursage, creosotebush, Torrey Mormon tea, white ratany

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 36 degrees, 14 minutes, 4 second north latitude; 113 degrees, 57 minutes, 13 second west longitude.

A—0 to 2 inches; yellowish brown (10YR 5/4) extremely gravelly sandy loam, brown (10YR 4/3) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine and fine and few medium roots; common very fine and fine tubular pores; 65 percent gravel; strongly effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bw1—2 to 8 inches; yellowish brown (10YR 5/4) gravelly sandy clay loam, dark yellowish brown (10YR 4/4) moist; weak fine and medium subangular blocky structure; soft, very friable, slightly sticky and moderately plastic; common very fine through medium

roots; common very fine and fine tubular pores; 30 percent gravel; strongly effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

Bw2—8 to 17 inches; yellowish brown (10YR 5/4) extremely gravelly sandy clay loam, dark yellowish brown (10YR 4/6) moist; massive; soft, very friable, slightly sticky and moderately plastic; common very fine and fine and few medium roots; common very fine and fine tubular pores; 75 percent gravel; common soft bodies consisting of decomposed granite and schist; few thin coats of calcium carbonate on the undersides of rock fragments; strongly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bk—17 to 27 inches; light yellowish brown (10YR 6/4) extremely gravelly sandy clay loam, yellowish brown (10YR 5/6) moist; massive; soft, very friable, moderately sticky and slightly plastic; few very fine and fine roots; few very fine tubular pores; 80 percent gravel; few thin coats of calcium carbonate on the undersides of rock fragments; strongly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Cr—27 inches; weathered fanglomerate dominated by granite, schist and gneiss clasts.

Range in Characteristics

Depth to paralithic contact: 22 to 32 inches

Clay content: averages 12 to 27 percent in the particle size control section

Rock fragments: average 60 to 80 percent, dominated by gravel, but there can be less than 60 percent in any one horizon

A horizon

Hue: 7.5YR, 10YR

Value: 5 or 6 dry, 3 or 4 moist

Chroma: 3 through 6, dry or moist

Bw horizons

Hue: 7.5YR, 10YR

Value: 5 or 6 dry, 4 or 5 moist

Chroma: 3 through 6, dry or moist

Reaction: moderately alkaline to strongly alkaline

Effervescence: slightly effervescent through violently effervescent

Calcium carbonate equivalent: 1 to 10 percent

Calcium carbonate: is disseminated or occurs as thin coats on the underside of rock fragments

Texture: coarse sandy loam, sandy loam, sandy clay loam

Bk horizon

Hue: 7.5YR, 10YR
 Value: 6 or 7 dry, 4 or 5 moist
 Chroma: 4 through 6, dry or moist
 Reaction: moderately alkaline to strongly alkaline
 Effervescence: strongly effervescent or violently effervescent
 Calcium carbonate equivalent: 5 to 15 percent
 Calcium carbonate: typically occurs as thin coats on the underside of rock fragments or is disseminated; weathered limestone clasts are present in some pedons.
 Texture: coarse sandy loam, sandy loam, sandy clay loam

Cr horizon

Consists of fanglomerate that is dominated by gravel and cobble-sized granite, schist and gneiss clasts with less than 5 percent limestone clasts. It is rigid through very rigid when dry, friable through extremely firm when moist. As much as 15 percent (air-dried) slakes when submerged in water.

13—Bobzbulz-Snapcan association

Map Unit Setting

Landform: fan terrace
Elevation: 1,150 to 2,100 feet (350 to 640 meters)
Mean annual precipitation: 3 to 9 inches (76 to 229 millimeters)
Mean annual air temperature: 64 to 73 degrees F (18 to 23 degrees C)
Mean annual soil temperature: 66 to 75 degrees F (19 to 24 degrees C)
Frost-free period: 230 to 340 days

Map Unit Composition

Bobzbulz and similar soils: 55 percent
 Snapcan and similar soils: 40 percent
 Minor components: 5 percent

- Arizo occasionally flooded
- Carrizo occasionally flooded
- Soils on toeslopes that are very deep to granitic fanglomerate
- Soils on steeper slopes

Properties and Qualities

Bobzbulz soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, thermic Typic Haplocambids

Geomorphic position: north-facing side slopes of fan terraces
Parent material: colluvium and/or residuum weathered from noncalcareous conglomerate
Slope: 30 to 55 percent
Surface fragments: about 35 percent coarse gravel, about 5 percent cobbles, about 5 percent stones
Depth to restrictive feature: 22 to 32 inches to bedrock (paralithic)
Drainage class: Well drained
Permeability: about 4.0 in/hr (moderately rapid)
Available water capacity total inches: 1.5
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: High
Hydrologic group: C
Major Land Resource Area: 30
Land Resource Unit: 30-2
Ecological site name: Limy Slopes 6-9" p.z.
Ecosystem site number: 030XB212AZ
Present native vegetation: white bursage, creosotebush, Torrey Mormon tea, white ratany
Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 2,788 feet west of

common very fine and few fine roots; few fine tubular pores; 35 percent gravel, 5 percent cobble; common thin coats of calcium carbonate on the undersides of rock fragments; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bk—14 to 30 inches; pale brown (10YR 6/4) extremely gravelly coarse sandy loam, dark yellowish brown (10YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; few very fine tubular pores; 65 percent gravel; common thin coats of calcium carbonate on the undersides of rock fragments; violently effervescent; moderately alkaline (pH 8.4); clear irregular boundary.

Cr—30 to 60 inches; weathered fanglomerate dominated by granite, schist and gneiss clasts.

Range in Characteristics

Depth to paralithic contact: 22 to 32 inches

Clay content: averages 12 to 20 percent in the particle size control section

Rock fragments: average 60 to 80 percent, dominated by gravel, but there can be less than 60 percent in any one horizon

Organic matter content: 0.1 to 0.5 percent

A horizon

Hue: 7.5YR, 10YR

Value: 5 or 6 dry, 3 or 4 moist

Chroma: 3 through 6, dry or moist

Bw horizons

Hue: 7.5YR, 10YR

Value: 5 or 6 dry, 4 or 5 moist

Chroma: 3 through 6, dry or moist

Reaction: moderately alkaline to strongly alkaline

Effervescence: slightly effervescent through violently effervescent

Calcium carbonate equivalent: 1 to 10 percent

Calcium carbonate: is disseminated or occurs as thin coats on the underside of rock fragments

Texture of fine earth: coarse sandy loam, sandy clay loam

Bk horizon

Hue: 7.5YR, 10YR

Value: 6 or 7 dry, 4 or 5 moist

Chroma: 4 through 6, dry or moist

Reaction: moderately alkaline to strongly alkaline

Effervescence: strongly effervescent or violently effervescent

Calcium carbonate equivalent: 5 to 15 percent

Calcium carbonate: typically occurs as thin coats on the underside of rock fragments or is

disseminated; weathered limestone clasts are present in some pedons.

Texture of fine earth: coarse sandy loam, sandy clay loam

Cr horizon

Consists of fanglomerate that is dominated by gravel and cobble-sized granite, schist and gneiss clasts with less than 5 percent limestone clasts. It is rigid through very rigid when dry, friable through extremely firm when moist. As much as 15 percent (air-dried) slakes when submerged in water.

Snapcan soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, hyperthermic Typic Haplocambids

Geomorphic position: south-facing side slopes of fan terraces

Parent material: colluvium and/or residuum weathered from noncalcareous conglomerate

Slope: 30 to 55 percent

Surface fragments: about 40 percent coarse gravel, about 5 percent boulders, about 10 percent stones, about 20 percent cobbles

Depth to restrictive feature: 22 to 30 inches to bedrock (paralithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 1.5

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: High

Hydrologic group: C

Major Land Resource Area: 30

Land Resource Unit: 30-1

Ecological site name: Limy Slopes 3-6" p.z.

Ecosystem site number: 030XA107AZ

Present native vegetation: creosotebush, white bursage, white brittlebush

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 5,182 feet northeast of Million Hills; 36 degrees, 10 minutes, 52 seconds north latitude; 113 degrees, 59 minutes, 17 seconds west longitude.

A—0 to 2 inches; light yellowish brown (10YR 6/4) extremely cobbly fine sandy loam, dark yellowish brown (10YR 3/6) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; few very fine tubular pores; 40 percent gravel, 20 percent cobble, 5 percent stone;

violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bw1—2 to 8 inches; light yellowish brown (10YR 6/4) very gravelly loam, dark yellowish brown (10YR 4/4) moist; weak fine and medium subangular blocky structure; soft, very friable, slightly sticky and moderately plastic; common very fine and fine roots; few very fine and fine tubular pores; 30 percent gravel, 5 percent cobble, 5 percent stone; violently effervescent; strongly alkaline (pH 8.6); clear wavy boundary.

Bw2—8 to 15 inches; brownish yellow (10YR 6/6) extremely gravelly loam, yellowish brown (10YR 5/6) moist; weak fine and medium subangular blocky structure; soft, very friable, slightly sticky and moderately plastic; common fine and medium roots; few very fine and fine tubular pores; 45 percent gravel, 10 percent cobble, 5 percent stone; violently effervescent; strongly alkaline (pH 8.6); clear irregular boundary.

Bk—15 to 26 inches; yellow (10YR 7/6) extremely gravelly sandy clay loam, dark yellowish brown (10YR 4/6) moist; massive; slightly hard, friable, moderately sticky and moderately plastic; few very fine through medium roots; few fine and medium tubular pores; 65 percent gravel, 10 percent cobble; common fine filaments of calcium carbonate; strongly effervescent; strongly alkaline (pH 8.6); abrupt irregular boundary.

Cr—26 to 60 inches; weathered fanglomerate dominated by granite, schist and gneiss clasts.

Range in Characteristics

Depth to paralithic contact: 22 to 30 inches
Clay content: averages 18 to 24 percent in the particle size control section
Rock fragments: 40 to 75 percent, gravel, cobble, stone

A horizon

Hue: 7.5YR, 10YR
Value: 5 or 6 dry, 3 or 4 moist
Chroma: 3 through 6, dry or moist
Calcium carbonate equivalent: 1 to 5 percent

Bw horizons

Hue: 7.5YR, 10YR
Value: 5 or 6 dry, 4 or 5 moist
Chroma: 3 through 6, dry or moist
Reaction: moderately alkaline to strongly alkaline
Effervescence: slightly effervescent through violently effervescent
Calcium carbonate equivalent: 1 to 5 percent

Texture of fine earth: coarse sandy loam, sandy clay loam, loam

Bk horizon

Hue: 7.5YR, 10YR
Value: 5 through 7 dry, 4 or 5 moist
Chroma: 3 through 6, dry or moist
Reaction: moderately alkaline to strongly alkaline
Effervescence: strongly or violently effervescent
Calcium carbonate equivalent: 5 to 15 percent
Calcium carbonate: occurs as thin coats on undersides of rock fragments, as filaments and is disseminated
Texture of fine earth: coarse sandy loam, sandy clay loam, loam

Cr horizon

Consists of fanglomerate that is dominated by gravel and cobble-sized granite, schist and gneiss clasts. It is rigid through very rigid when dry, friable through extremely firm when moist. As much as 15 percent (air-dried) slakes when submerged in water.

14—Calcic Petrocalcids, 2 to 15 percent slopes

Map Unit Setting

Landform: plateau
Elevation: 4,500 to 5,000 feet (1,372 to 1,524 meters)
Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)
Mean annual air temperature: 55 to 57 degrees F (13 to 14 degrees C)
Mean annual soil temperature: 57 to 59 degrees F (15 to 16 degrees C)
Frost-free period: 180 to 200 days

Map Unit Composition

Calcic Petrocalcids and similar soils: 100 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Calcic Petrocalcids soils

Taxonomic classification: Calcic Petrocalcids
Geomorphic position: summits and side slopes of fan terraces on colluvial slopes of plateau escarpments
Parent material: alluvium derived from limestone

Slope: 2 to 15 percent

Depth to restrictive feature: 9 to 15 inches to petrocalcic

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Upland, Shallow 6-10" p.z.

Ecosystem site number: 035XE519AZ

Present native vegetation: blackbrush, ephedra, Opuntia, banana yucca

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Sanup Plateau, 2.37 miles southwest of Fort Garrett; 36 degrees, 6 minutes, 35 seconds north latitude; 113 degrees, 49 minutes, 45 seconds west longitude.

A—0 to 2 inches; yellowish brown (10YR 5/4) very gravelly loam; dark yellowish brown (10YR 3/4) moist; moderate medium granular structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; common fine irregular pores; 40 percent gravel; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bk1—2 to 6 inches; yellowish brown (10YR 5/4) gravelly silt loam; dark yellowish brown (10YR 3/6) moist; moderate medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine and fine roots; common fine tubular pores; moderately thick calcium carbonate coats and pendants on the undersides and sides of rock fragments; 20 percent gravel; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bk1—6 to 10 inches; yellowish brown (10YR 5/4) very gravelly loam; dark yellowish brown (10YR 3/4) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few very fine and fine roots; few fine tubular pores; moderately thick calcium carbonate coats and pendants on the undersides and sides of rock fragments; 45 percent gravel; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bkm—10 inches; indurated petrocalcic horizon.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific

horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

15—Calcic Petrocalcids—Calcic Petrocalcids, moderately steep-Rock outcrop complex, Hermit Formation, 2 to 50 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,600 to 4,900 feet (1,403 to 1,494 meters)

Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)

Mean annual air temperature: 54 to 57 degrees F (12 to 14 degrees C)

Mean annual soil temperature: 56 to 59 degrees F (14 to 16 degrees C)

Frost-free period: 135 to 150 days

Map Unit Composition

Calcic Petrocalcids and similar soils: 40 percent
Calcic Petrocalcids, moderately steep, and similar soils: 30 percent
Rock outcrop: 30 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Calcic Petrocalcids soils

Taxonomic classification: Calcic Petrocalcids

Geomorphic position: summits of fan terraces on colluvial slopes of escarpments

Parent material: alluvium derived from limestone and/or colluvium derived from limestone

Slope: 2 to 15 percent

Depth to restrictive feature: 4 to 20 inches to petrocalcic

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Shallow Upland, Calcareous 10-14" p.z.

Ecosystem site number: 035XC331AZ

Present native vegetation: blackbrush, ephedra, desert

needlegrass, galleta, Stansbury cliffrose, banana yucca

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Esplanade; 2.22 miles south of Lost Spring; 36 degrees, 7 minutes, 26 seconds north latitude; 113 degrees, 22 minutes, 53 seconds west longitude.

A—0 to 2 inches; strong brown (7.5YR 4/6) very gravelly loam; dark brown (7.5YR 3/4) moist; weak fine subangular blocky structure; soft, friable, nonsticky and nonplastic; few very fine roots; few fine tubular pores; 35 percent gravel; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bk—2 to 12 inches; brown (7.5YR 4/4) very cobbly loam; brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common fine roots; few fine tubular pores; 15 percent gravel, 20 percent cobble; common thick calcium carbonate coats on the undersides of rock fragments; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

Bkm—12 inches; indurated petrocalcic horizon with thin laminar cap.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Calcic Petrocalcids, moderately steep, soils

Taxonomic classification: Calcic Petrocalcids

Geomorphic position: shoulders and sideslopes of fan terraces on colluvial slopes of escarpments

Parent material: alluvium derived from limestone and/or colluvium derived from limestone

Slope: 15 to 50 percent

Depth to restrictive feature: 4 to 20 inches to petrocalcic

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Limy Slopes, Calcareous 10-14" p.z.

Ecosystem site number: 035XC344AZ

Present native vegetation: blackbrush, ephedra, desert needlegrass, galleta, Stansbury cliffrose, banana yucca

Land capability (nonirrigated): 6c

Taxonomic Unit Description

A—0 to 2 inches; strong brown (7.5YR 4/6) very gravelly loam; dark brown (7.5YR 3/4) moist; weak fine subangular blocky structure; soft, friable, nonsticky and nonplastic; few very fine roots; few fine tubular pores; 35 percent gravel; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bk—2 to 12 inches; brown (7.5YR 4/4) very cobbly loam; brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common fine roots; few fine tubular pores; 15 percent gravel, 20 percent cobble; common thick calcium carbonate coats on the undersides of rock fragments; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

Bkm—12 inches; indurated petrocalcic horizon with thin laminar cap.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Rock outcrop

Pediments and steep escarpments of the Hermit Formation

16—Calcic Petrocalcids-Rock outcrop complex, 15 to 55 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,500 to 4,500 feet (1,067 to 1,372 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 200 to 240 days

Map Unit Composition

Calcic Petrocalcids and similar soils: 80 percent
Rock outcrop: 20 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Calcic Petrocalcids soils

Taxonomic classification: Calcic Petrocalcids

Geomorphic position: summits of fan terraces and colluvial toeslopes on canyon side walls

Parent material: alluvium derived from limestone, sandstone, and shale and/or colluvium derived from limestone, sandstone, and shale

Slope: 15 to 55 percent

Depth to restrictive feature: 10 to 20 inches to petrocalcic

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Slopes, Shallow 6-10" p.z.

Ecosystem site number: 035XE517AZ

Present native vegetation: blackbrush, ephedra, banana yucca

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Tonto Platform; 1,300 feet southwest of Plateau Point; 36 degrees, 5 minutes, 19 seconds north latitude; 112 degrees, 7 minutes, 47 seconds west longitude.

A—0 to 3 inches; very pale brown (10YR 7/3) very stony loam; dark yellowish brown (10YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; few very fine irregular pores; 20 percent gravel, 5 percent cobble, 20 percent stone; violently effervescent; moderately alkaline; clear smooth boundary.

Bk1—3 to 8 inches; pink (7.5YR 7/3) very cobbly loam; brown (7.5YR 5/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine through medium roots; few fine tubular pores; many moderately thick calcium

carbonate coats on the undersides of rock fragments; 20 percent gravel, 15 percent cobble, and 5 percent stone; violently effervescent; moderately alkaline; gradual wavy boundary.

Bk2—8 to 15 inches; pink (7.5YR 7/3) very cobbly loam; brown (7.5YR 5/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine and medium roots; few fine tubular pores; many coarse soft masses of calcium carbonate; 20 percent gravel, 15 percent cobble, and 5 percent stone; violently effervescent; moderately alkaline; abrupt smooth boundary.

Bkm—15 to 60 inches; pink (7.5YR 8/3) indurated petrocalcic horizon.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Rock outcrop

Cliffs and escarpments of the Hermit Formation

17—Calcic Petrocalcids-Typic Haplocambids complex, 15 to 30 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,500 to 5,000 feet (1,372 to 1,524 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 55 to 57 degrees F (13 to 14 degrees C)

Mean annual soil temperature: 57 to 59 degrees F (15 to 16 degrees C)

Frost-free period: 180 to 195 days

Map Unit Composition

Calcic Petrocalcids and similar soils: 60 percent
Typic Haplocambids and similar soils: 40 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor

components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Calcic Petrocalcids soils

Taxonomic classification: Calcic Petrocalcids

Geomorphic position: summits of fan terraces on canyon escarpments

Parent material: alluvium derived from limestone and sandstone and/or colluvium derived from limestone and sandstone

Slope: 15 to 30 percent

Depth to restrictive feature: 9 to 15 inches to petrocalcic

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Slopes, Shallow 6-10" p.z.

Ecosystem site number: 035XE517AZ

Present native vegetation: blackbrush, ephedra, banana yucca

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Tonto Platform; 680 feet southwest of Indian Garden; 36 degrees, 4 minutes, 55 seconds north latitude; 112 degrees, 7 minutes, 35 seconds west longitude.

A—0 to 2 inches; pale brown (10YR 6/3) very cobbly loam; dark yellowish brown (10YR 4/4) moist; moderate thin platy structure parting to weak very fine and fine subangular blocky; soft, very friable, slightly sticky and nonplastic; few very fine and fine roots, common fine vesicular and tubular pores; 30 percent gravel, 20 percent cobble; slightly effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bk1—2 to 8 inches; pale brown (10YR 6/3) very cobbly very fine sandy loam; dark yellowish brown (10YR 4/4) moist; moderate fine subangular blocky structure; soft, very friable, slightly sticky and nonplastic; few very fine and fine roots; common very fine and fine tubular pores; many thick calcium carbonate coats and pendants on the undersides and sides of rock fragments; 20 percent gravel, 30 percent cobble; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bk2—8 to 13 inches; very pale brown (10YR 7/3) very cobbly very fine sandy loam; yellowish brown (7.5YR 5/4) moist; weak fine subangular blocky structure; soft,

very friable, slightly sticky and nonplastic; common very fine through medium and few coarse roots; common very fine and fine and few medium tubular pores; many thick calcium carbonate coats and pendants on the undersides and sides of rock fragments; 20 percent gravel, 30 percent cobble; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

Bkm—13 inches; indurated petrocalcic horizon.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Typic Haplocambids soils

Taxonomic classification: Typic Haplocambids

Geomorphic position: side slopes and toeslopes of fan terraces on canyon escarpments

Parent material: alluvium derived from calcareous sandstone and/or residuum weathered from calcareous sandstone

Slope: 15 to 30 percent

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Slopes 6-10" p.z.

Ecosystem site number: 035XE507AZ

Present native vegetation: black grama, desert needlegrass, blackbrush, blue threeawn, ephedra, Opuntia

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Tonto Platform; 1,876 feet southwest of Indian Garden; 36 degrees, 4 minutes, 53 seconds north latitude; 112 degrees, 7 minutes, 32 seconds west longitude.

A—0 to 3 inches; brown (7.5YR 5/4) extremely gravelly sandy loam; brown (7.5YR 4/4) moist; moderate thin platy structure; slightly hard, very friable, moderately sticky and slightly plastic; common very fine roots; common very fine and fine vesicular pores; 50 percent gravel, 15 percent cobble; slightly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bw1—3 to 8 inches; strong brown (7.5YR 4/6) very gravelly very fine sandy loam; brown (7.5YR 4/4) moist; moderate fine subangular blocky structure; slightly hard, very friable, moderately sticky and slightly plastic; many very fine and fine roots; many very fine and fine tubular pores; 45 percent gravel, 5 percent cobble; slightly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bw2—8 to 22 inches; strong brown (7.5YR 4/6) very gravelly sandy loam; brown (7.5YR 4/4) moist; strong medium subangular blocky structure; hard, friable, moderately sticky and moderately plastic; common very fine and fine roots; many very fine and fine and common medium tubular pores; 45 percent gravel; slightly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

C—22 to 60 inches; strong brown (7.5YR 4/6) very gravelly sandy loam; brown (7.5YR 4/4) moist; massive; slightly hard, very friable, nonsticky and nonplastic; 40 percent gravel; slightly effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

18—Carrizo complex, 1 to 5 percent slopes

Map Unit Setting

Landform: flood plain

Elevation: 1,200 to 1,600 feet (366 to 488 meters)

Mean annual precipitation: 3 to 6 inches (76 to 152 millimeters)

Mean annual air temperature: 70 to 75 degrees F (21 to 24 degrees C)

Mean annual soil temperature: 72 to 77 degrees F (23 to 26 degrees C)

Frost-free period: 300 to 365 days

Map Unit Composition

Carrizo and similar soils: 50 percent

Carrizo and similar soils: 30 percent

Minor components: 20 percent

Properties and Qualities

Carrizo soils

Taxonomic classification: sandy-skeletal, mixed, hyperthermic Typic Torriorthents

Geomorphic position: flood plains and dry washes

Parent material: alluvium

Slope: 1 to 5 percent

Surface fragments: about 5 percent cobbles, about 50 percent coarse gravel

Drainage class: Excessively drained

Permeability: about 13.00 in/hr (rapid)

Available water capacity total inches: 1.8

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: Occasional

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Negligible

Hydrologic group: A

Major Land Resource Area: 30

Land Resource Unit: 30-1

Ecological site name: Sandy Wash 3-6" p.z.

Ecosystem site number: 030XA115AZ

Present native vegetation: white burrobrush, catclaw acacia, big galleta, creosotebush, white brittlebush, white bursage

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 36 degrees, 15 minutes, 30 seconds north latitude; 114 degrees, 0 minutes, 10 seconds west longitude.

C1—0 to 13 inches; reddish yellow (7.5YR 6/6) very gravelly loamy sand, brown (7.5YR 4/4) moist; single grain; loose, nonsticky and nonplastic; few fine and medium roots; many very fine irregular pores; 50 percent gravel, 5 percent cobble; strongly effervescent; slightly alkaline (pH 7.6); gradual smooth boundary.

C2—13 to 60 inches; reddish yellow (7.5YR 6/6) stratified extremely stony coarse sand to extremely gravelly loamy sand, brown (7.5YR 4/4) moist; single grain; loose, nonsticky and nonplastic; few fine and medium roots; many very fine irregular pores; 50 percent gravel, 20 percent cobble, 5 percent stone; strongly effervescent; slightly alkaline (pH 7.8).

Range in Characteristics

Rock fragments: average 35 to 75 percent gravel, cobble or stone in the particle size control section
Stratification: textures range from loamy sand to very coarse sand and are highly variable with depth.
Reaction: slightly alkaline to moderately alkaline

Effervescence: slightly or strongly effervescent
Organic matter: less than 0.5 percent

C horizons

Hue: 7.5YR, 10YR
Value: 4 through 7 dry, 2 through 6 moist
Chroma: 2 through 6 dry, 2 through 4 moist
Texture: sand, loamy sand, coarse sand, loamy coarse sand

Carrizo soils

Taxonomic classification: sandy-skeletal, mixed, hyperthermic Typic Torriorthents
Geomorphic position: flood plains and dry washes
Parent material: alluvium
Slope: 1 to 5 percent
Surface fragments: about 20 percent coarse gravel, about 30 percent cobbles, about 5 percent stones
Drainage class: Excessively drained
Permeability: about 13.00 in/hr (rapid)
Available water capacity total inches: 1.8
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: Occasional
Seasonal water table minimum depth: greater than 6 feet
Runoff class: Negligible
Hydrologic group: A
Major Land Resource Area: 30
Land Resource Unit: 30-1
Ecological site name: Sandy Wash 3-6" p.z.
Ecosystem site number: 030XA115AZ
Present native vegetation: white burrobrush, catclaw acacia, big galleta, creosotebush, white brittlebush, white bursage
Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 36 degrees, 15 minutes, 35 seconds north latitude; 114 degrees, 0 minutes, 34 seconds west longitude.

C1—0 to 3 inches; light brown (7.5YR 6/4) very cobbly loamy sand, brown (7.5YR 4/4) moist; single grain; loose, nonsticky and nonplastic; few very fine roots; many very fine irregular pores; 25 percent gravel, 25 percent cobble, 5 percent stone; slightly effervescent; slightly alkaline (pH 7.8); gradual wavy boundary.

C2—3 to 60 inches; light brown (7.5YR 6/4) stratified extremely stony coarse sand to extremely gravelly coarse sand, brown (7.5YR 4/4) moist; single grain; loose, nonsticky and nonplastic; few very fine and fine roots; many very fine irregular pores; 70 percent gravel; slightly effervescent; slightly alkaline (pH 7.8).

Range in Characteristics

Rock fragments: average 35 to 75 percent gravel, cobble or stone in the particle size control section
Stratification: textures range from loamy sand to very coarse sand and are highly variable with depth
Reaction: slightly alkaline to moderately alkaline
Effervescence: slightly or strongly effervescent
Organic matter: less than 0.5 percent

C horizons

Hue: 7.5YR, 10YR
Value: 4 through 7 dry, 2 through 6 moist
Chroma: 2 through 6 dry, 2 through 4 moist
Texture: sand, loamy sand, coarse sand, loamy coarse sand

19—Carrizo-Carrizo-Riverbend association

Map Unit Setting

Landform: flood plain
Elevation: 1,150 to 1,600 feet (350 to 488 meters)
Mean annual precipitation: 3 to 6 inches (76 to 152 millimeters)
Mean annual air temperature: 70 to 75 degrees F (21 to 24 degrees C)
Mean annual soil temperature: 72 to 77 degrees F (23 to 26 degrees C)
Frost-free period: 300 to 360 days

Map Unit Composition

Carrizo and similar soils: 45 percent
Carrizo and similar soils: 25 percent
Riverbend and similar soils: 20 percent
Minor components: 10 percent

- Carrizo frequently flooded
- Huevi very gravelly fine sandy loam
- Soils that have a stony surface phase

Properties and Qualities

Carrizo soils

Taxonomic classification: sandy-skeletal, mixed, hyperthermic Typic Torriorthents
Geomorphic position: stream terraces in drainageways
Parent material: alluvium
Slope: 2 to 8 percent
Surface fragments: about 10 percent coarse gravel, about 40 percent cobbles
Drainage class: Excessively drained
Permeability: about 13.00 in/hr (rapid)

Available water capacity total inches: 1.7
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: very low
Hydrologic group: A
Major Land Resource Area: 30
Land Resource Unit: 30-1
Ecological site name: Cobbly Sandy Upland 3-6" p.z.
Ecosystem site number: 030XA122AZ
Present native vegetation: white bursage, creosotebush, big galleta, white burrobrush, catclaw acacia
Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: Clark County, Nevada; about 1,600 feet east and 600 feet south of the northwest corner of section 16, T. 29 N., R. 65 E.; 35 degrees, 25 minutes, 25 seconds north latitude; 114 degrees, 45 minutes, 37 seconds west longitude.

C1—0 to 10 inches; reddish yellow (7.5YR 6/6) very cobbly coarse sand, brown (7.5YR 4/4) moist; single grain; loose, nonsticky and nonplastic; few fine and medium roots; many very fine irregular pores; 40 percent cobble, 10 percent gravel; strongly effervescent; slightly alkaline (pH 7.6); gradual smooth boundary.

C2—10 to 60 inches; reddish yellow (7.5YR 6/6) stratified extremely gravelly coarse sand to very gravelly sand, brown (7.5YR 4/4) moist; single grain; loose, nonsticky and nonplastic; few fine and medium roots; many very fine irregular pores; 50 percent gravel, 20 percent cobble, 5 percent stone; strongly effervescent; slightly alkaline (pH 7.8); gradual smooth boundary.

Range in Characteristics

Rock fragments: average 35 to 75 percent gravel, cobble or stone in the particle size control section and is highly stratified

Reaction: slightly alkaline to moderately alkaline

Effervescence: slightly or strongly effervescent

Organic matter: less than 0.5 percent

C horizons

Hue: 7.5YR, 10YR

Value: 5 through 7 dry, 2 through 6 moist

Chroma: 2 through 6 dry, 2 through 4 moist

Texture: sand, loamy sand, coarse sand, loamy coarse sand

Carrizo soils

Taxonomic classification: sandy-skeletal, mixed, hyperthermic Typic Torriorthents
Geomorphic position: flood plains in drainageways
Parent material: alluvium
Slope: 2 to 8 percent
Surface fragments: about 5 percent cobbles, about 60 percent coarse gravel, about 5 percent stones
Drainage class: Excessively drained
Permeability: about 19.98 in/hr (very rapid)
Available water capacity total inches: 1.3
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: Occasional
Seasonal water table minimum depth: greater than 6 feet

Runoff class: very low

Hydrologic group: A

Major Land Resource Area: 30

Land Resource Unit: 30-1

Ecological site name: Sandy Wash 3-6" p.z.

Ecosystem site number: 030XA115AZ

Present native vegetation: white burrobrush, catclaw acacia, big galleta, creosotebush, white brittlebush, white bursage

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: Clark County, Nevada; about 1,600 feet east and 600 feet south of the northwest corner of section 16, T. 29 N., R. 65 E.; 35 degrees, 25 minutes, 25 seconds north latitude; 114 degrees, 45 minutes, 37 seconds west longitude.

C1—0 to 10 inches; light brown (7.5YR 6/4) extremely gravelly sand, brown (7.5YR 4/4) moist; single grain; loose, nonsticky and nonplastic; few very fine roots; many very fine irregular pores; 60 percent gravel, 5 percent cobble, 5 percent stone; slightly effervescent; slightly alkaline (pH 7.8); gradual wavy boundary.

C2—10 to 60 inches; light brown (7.5YR 6/4) stratified extremely gravelly coarse sand to very gravelly sand, brown (7.5YR 4/4) moist; single grain; loose, nonsticky and nonplastic; few very fine and fine roots; many very fine irregular pores; 70 percent gravel; slightly effervescent; slightly alkaline (pH 7.8); gradual wavy boundary.

Range in Characteristics

Rock fragments: average 35 to 75 percent gravel, cobble or stone in the particle size control section

Reaction: slightly alkaline to moderately alkaline

Effervescence: slightly or strongly effervescent

Organic matter: less than 0.5 percent

C horizons

Hue: 7.5YR, 10YR

Value: 5 through 7 dry, 2 through 6 moist

Chroma: 2 through 6 dry, 2 through 4 moist

Texture: sand, loamy sand, coarse sand, loamy coarse sand

Riverbend soils

Taxonomic classification: sandy-skeletal, mixed, hyperthermic Typic Haplocalcids

Geomorphic position: summits and side slopes of fan terraces

Parent material: alluvium

Slope: 4 to 15 percent

Surface fragments: about 5 percent cobbles, about 25 percent coarse gravel

Drainage class: Excessively drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 1.9

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Low

Hydrologic group: C

Major Land Resource Area: 30

Land Resource Unit: 30-1

Ecological site name: Limy Fan, Sandy 3-6" p.z.

Ecosystem site number: 030XA121AZ

Present native vegetation: white bursage, creosotebush, big galleta, white ratany, Opuntia

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: Clark County, Nevada; about 300 feet west and 800 feet south of the northeast corner of section 2, T. 29 N, R. 65 E.; 35 degrees, 27 minutes, 18 seconds north latitude; 114 degrees, 41 minutes, 14 seconds west longitude.

A—0 to 10 inches; brown (7.5YR 5/4) gravelly loamy sand, dark brown (7.5YR 4/4) moist; moderate medium platy structure; soft, friable, nonsticky and nonplastic; common fine roots; many fine irregular pores; 25 percent gravel, 5 percent cobble; strongly effervescent; moderately alkaline (pH 8.0); abrupt wavy boundary.

2C—10 to 19 inches; brown (7.5YR 5/4) stratified very gravelly coarse sand to very gravelly loamy coarse sand, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; soft, friable, nonsticky and nonplastic; common fine roots; common fine

tubular pores; 5 percent cobble and 30 percent gravel; strongly effervescent; moderately alkaline (pH 8.0); abrupt wavy boundary.

3Bk1—19 to 31 inches; brown (7.5YR 6/4) very gravelly loamy coarse sand, brown (7.5YR 5/4) moist; massive; loose, nonsticky and nonplastic; common fine roots; common fine tubular pores; 5 percent cobble and 30 percent gravel; strongly effervescent; moderately alkaline (pH 8.0); abrupt wavy boundary.

3Bk2—31 to 34 inches; brown (7.5YR 6/4) very gravelly loamy coarse sand, brown (7.5YR 5/4) moist; single grain; loose, nonsticky and nonplastic; few very fine roots; common fine irregular pores; 40 percent gravel; common medium soft masses of calcium carbonate; many thin coats of calcium carbonate on undersides of rock fragments; violently effervescent; moderately alkaline (pH 8.2); clear wavy boundary.

3Bk3—34 to 60 inches; brown (7.5YR 5/4) very gravelly sand, dark brown (7.5YR 4/4) moist; single grain; loose, nonsticky and nonplastic; few very fine roots; common fine irregular pores; 10 percent cobble and 45 percent gravel; many thin coats of calcium carbonate on undersides of rock fragments; strongly effervescent; moderately alkaline (pH 8.0).

Range in Characteristics

Rock fragments: average 35 to 75 percent gravel or cobble in the particle size control section

Reaction: slightly alkaline to moderately alkaline

Calcium carbonate equivalent: 7 to 20 percent

Organic matter: less than 0.5 percent

A horizon

Hue: 7.5YR, 10YR

Value: 5 through 7 dry, 4 through 6 moist

Chroma: 3 or 4, dry or moist

B horizon

Hue: 7.5YR, 10YR

Value: 5 through 7 dry, 4 through 6 moist

Chroma: 3 or 4, dry or moist

Texture: loamy sand, sand, coarse sand, loamy coarse sand; some pedons may contain strata of sandy loam and loam

20—Childers-Lava Flows association, 4 to 15 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,200 to 4,800 feet (1,280 to 1,463 meters)
Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)
Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)
Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)
Frost-free period: 145 to 150 days

Map Unit Composition

Childers and similar soils: 55 percent
 Lava Flows: 35 percent
 Minor components: 10 percent

- Soils that are more than 20 inches deep to bedrock
- Soils formed in residuum and colluvium derived from volcanic cinders
- Soils that have more than 28 percent clay in the particle size control section
- Soils that have a cobbly or stony surface phase
- Soils that do not have calcium carbonates within the profile
- Soils that do not have a hardpan and are less than 20 inches deep to hard bedrock

Properties and Qualities

Childers soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic, shallow Calcic Petrocalcids
Geomorphic position: Concavities and depressions between ridges of basalt flows
Parent material: colluvium and/or residuum weathered from basalt
Slope: 4 to 15 percent
Surface fragments: about 5 percent boulders, about 45 percent coarse gravel, about 15 percent cobbles, about 5 percent stones
Depth to restrictive feature: 20 to 40 inches to bedrock (lithic); 10 to 20 inches to petrocalcic
Drainage class: Well drained
Permeability: about 1.30 in/hr (moderate)
Available water capacity total inches: 1.4
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: Medium
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-3
Ecological site name: Basalt Upland 10-14" p.z.

Ecosystem site number: 035XC301AZ
Present native vegetation: Wyoming big sagebrush, blue grama, Colorado pinyon, Utah juniper, black grama, fourwing saltbush
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: about 1,500 feet south and 1,900 feet east of the northwest corner of section 13, township 40 north, range 11 west; 36 degrees, 52 minutes, 17.1 seconds north latitude; 113 degrees, 25 minutes, 33.8 seconds west longitude.

A—0 to 1 inch; brown (7.5YR 5/4) very gravelly silt loam; brown (7.5YR 4/4) moist; moderate thin platy structure; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; many very fine and fine irregular and few fine tubular pores; many moderately thick calcium carbonate coats on rock fragments; violently effervescent; 30 percent gravel, 5 percent cobble; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bk1—1 to 5 inches; light brown (7.5YR 6/3) gravelly loam; brown (7.5YR 4/3) moist; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and few fine roots; common fine tubular pores; common fine calcium carbonate filaments; many very thick calcium carbonate coats and pendants on the undersides of rock fragments; violently effervescent; 25 percent gravel; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bk2—5 to 10 inches; light brown (7.5YR 6/3) very gravelly loam; brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and fine roots; few fine tubular pores; common fine calcium carbonate filaments; many very thick calcium carbonate coats and pendants on the undersides of rock fragments; violently effervescent; 30 percent gravel, 5 percent cobble; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bk3—10 to 15 inches; light brown (7.5YR 6/3) very gravelly loam; brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and few fine roots; common fine tubular pores; common fine calcium carbonate filaments; many fine hard masses of calcium carbonate; many very thick calcium carbonate coats and pendants on

the undersides of rock fragments; violently effervescent; 35 percent gravel; moderately alkaline (pH 8.4); abrupt wavy boundary.

Bkm—15 to 24 inches; indurated petrocalcic with a 5-millimeter-thick laminar cap; abrupt irregular boundary.

2R—24 inches; hard basalt bedrock.

Range in Characteristics

Depth to calcic horizon: 1 to 3 inches

Depth to petrocalcic horizon: 10 to 20 inches

Depth to bedrock: 20 to 40 inches

Rock fragments: average 35 to 50 percent

Clay content: averages 5 to 18 percent in the particle size control section.

A horizon

Hue: 7.5YR, 5YR

Value: 5 or 6 dry, 4 or 5 moist

Chroma: 3 or 4, dry or moist

Bk horizons

Hue: 7.5YR, 5YR

Value: 5 through 7 dry, 4 through 6 moist

Chroma: 3 or 4, dry or moist

Calcium carbonate equivalent: 15 to 40 percent

Lava Flows

Pressure ridges and push ups of fractured basalt

21—Chilton-Teesto-Puertecito families complex, 15 to 55 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,500 to 5,000 feet (1,372 to 1,524 meters)

Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)

Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)

Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)

Frost-free period: 145 to 160 days

Map Unit Composition

Chilton family and similar soils: 40 percent

Teesto family and similar soils: 30 percent

Puertecito family and similar soils: 25 percent

Minor components: 5 percent

- Soils that have petrocalcic horizons
- Soils in draineways that are subject to occasional flooding

- Talus slopes devoid of vegetation
- Rock outcrop
- Poorly drained soils in seeps

Properties and Qualities

Chilton family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, calcareous, mesic Ustic Torriorthents

Geomorphic position: fan terraces on colluvial slopes of canyons and plateau escarpments

Parent material: alluvium and/or colluvium derived from limestone and sandstone

Slope: 15 to 55 percent

Surface fragments: about 10 percent boulders, about 35 percent gravel, about 15 percent cobbles, about 15 percent stones

Drainage class: Well drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 3.0

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: B

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Sedimentary Cliffs 10-14" p.z.

Ecosystem site number: 035XC302AZ

Present native vegetation: other evergreen trees, pointleaf manzanita, turbinella oak, Wyoming big sagebrush, skunkbush sumac, spiny greasewood

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In Bright Angel Canyon; 2,707 feet north of The Transept; 36 degrees, 11 minutes, 2 seconds north latitude; 112 degrees, 2 minutes, 42 seconds west longitude.

A—0 to 2 inches; brown (7.5YR 5/4) extremely bouldery sandy loam; brown (7.5YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; common fine tubular pores; 25 percent cobble, 20 percent stone, and 20 percent boulder; strongly effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bk—2 to 18 inches; light brown (7.5YR 6/4) extremely bouldery sandy loam; brown (7.5YR 5/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and medium roots; few fine tubular pores; 20 percent cobble, 20

percent stone, and 30 percent boulder; violently effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

C—18 to 60 inches; brown (7.5YR 5/4) extremely bouldery sandy loam; massive; soft, very friable, nonsticky and nonplastic; few fine and medium roots; few fine tubular pores; 20 percent channers, 20 percent stone, and 30 percent boulder; violently effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Rock fragments: average 35 to 65 percent in the control section.

A horizon

Hue: 7.5YR through 2.5YR

Value: 4 through 6 dry, 3 through 5 moist

Chroma: 2 through 8

Dark colored epipedons are too thin to meet the requirements for a mollic epipedon.

Bk horizon

Hue: 7.5YR through 2.5YR

Value: 4 through 8 dry, 3 through 5 moist

Chroma: 2 through 6

Calcium carbonate equivalent: 5 to 15 percent

Clay content: 5 to 8 percent

C horizon

Calcium carbonate equivalent: 5 to 15 percent

Teesto family soils

Taxonomic classification: Loamy-skeletal, mixed, calcareous, mesic Lithic Ustic Torriorthents

Geomorphic position: pockets and ledges on steep cliffs and escarpments

Parent material: colluvium derived from limestone and sandstone

Slope: 15 to 55 percent

Surface fragments: about 50 percent coarse gravel, about 10 percent cobbles, about 20 percent stones

Depth to restrictive feature: 5 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 0.3

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Sedimentary Cliffs 10-14" p.z.

Ecosystem site number: 035XC302AZ

Present native vegetation: other evergreen trees, pointleaf manzanita, turbinella oak, Wyoming big sagebrush, skunkbush sumac, spiny greasewood

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In Bright Angel Canyon; 2,741 feet south of Bright Angel Point; 36 degrees, 11 minutes, 8 seconds north latitude; 112 degrees, 2 minutes, 56 seconds west longitude.

A—0 to 2 inches; light olive brown (2.5Y 5/4) extremely gravelly sandy loam; olive brown (2.5Y 4/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine roots; few fine tubular pores; 50 percent gravel, 10 percent cobble; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

C—2 to 6 inches; olive yellow (2.5Y 6/6) very gravelly sandy loam; light olive brown (2.5Y 5/6) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine roots, few fine tubular pores; 40 percent gravel, 5 percent cobble; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

R—6 inches; limestone bedrock.

Range in Characteristics

Rock fragments: 35 to 70 percent

Calcium carbonate equivalent: 5 to 40 percent

Depth to bedrock: 5 to 20 inches

Clay content: 5 to 10 percent

A and B horizons

Hue: 10YR, 7.5YR, 2.5Y

Value: 4 or 6 dry; 3, 4, or 5 moist

Chroma: 2, 3, or 4, dry or moist

Puertecito family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Ustic Haplargids

Geomorphic position: summits and side slopes of steep pediments

Parent material: residuum weathered from arkose

Slope: 15 to 55 percent

Surface fragments: about 40 channers, about 5 percent cobbles

Depth to restrictive feature: 6 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.40 in/hr (moderately slow)

Available water capacity total inches: 1.0

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Sedimentary Cliffs 10-14" p.z.

Ecosystem site number: 035XC302AZ

Present native vegetation: other evergreen trees, pointleaf manzanita, turbinella oak, Wyoming big sagebrush, skunkbush sumac, spiny greasewood

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In Bright Angel Canyon; 1,152 feet east of The Transept; 36 degrees, 10 minutes, 35 seconds north latitude; 112 degrees, 2 minutes, 20 seconds west longitude.

A—0 to 2 inches; light yellowish brown (2.5Y 6/3) very channery sandy loam; olive brown (2.5Y 4/3) moist; moderate thin platy structure; soft, very friable, nonsticky and nonplastic; common fine and medium roots, many very fine and fine tubular pores; 10 percent gravel, 30 percent channers; noneffervescent; moderately alkaline (pH 8.0); clear smooth boundary.

Bt—2 to 8 inches; brown (7.5YR 4/4) very gravelly clay loam; dark brown (7.5YR 3/4) moist; moderate fine subangular blocky structure; hard, firm, very sticky and very plastic; common fine and medium roots; common fine and medium tubular pores; common faint clay films on the faces of peds; 40 percent gravel; noneffervescent; moderately alkaline (pH 8.0); clear smooth boundary.

BC—8 to 12 inches; light yellowish brown (2.5Y 6/3) very gravelly clay loam; olive brown (2.5Y 4/3) moist; moderate fine subangular blocky structure; hard, friable, very sticky and very plastic; common fine and medium roots; common fine and medium tubular pores; common distinct brown (7.5YR 5/4) clay films lining pores and on faces of peds; 40 percent gravel; noneffervescent; moderately alkaline (pH 8.0); abrupt irregular boundary.

R—12 inches; hard shale bedrock.

Range in Characteristics

Clay content (control section): 30 to 35 percent

Rock fragment content (control section): 35 to 65 percent

Depth to bedrock: 6 to 20 inches

A horizon

Hue: 2.5Y, 10YR

Value: 5 or 6 dry

Chroma: 3 or 4, dry or moist

Bt horizon

Hue: 2.5Y, 5YR, 7.5YR

Value: 4 through 6 dry, 3 or 4 moist

Chroma: 3 or 4, dry or moist

Effervescence: noneffervescent to strongly effervescent

Calcium carbonate equivalent: 0 to 10 percent

Some pedons have a Btk horizon.

22—Chunkmonk-Wodomont-Houserock families complex, 15 to 40 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,000 to 6,000 feet (1,524 to 1,829 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)

Mean annual soil temperature: 50 to 54 degrees F (11 to 13 degrees C)

Frost-free period: 140 to 150 days

Map Unit Composition

Chunkmonk family and similar soils: 40 percent

Wodomont family and similar soils: 30 percent

Houserock family and similar soils: 15 percent

Minor components: 15 percent

- Soils that are moderately deep or deep to bedrock
- Soils that have a petrocalcic horizon
- Soils that do not have accumulation of clay in the profile
- Soils on steeper slopes
- Rock outcrop

Properties and Qualities

Chunkmonk family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Haplustalfs

Geomorphic position: summits

Parent material: residuum weathered from cherty limestone

Slope: 15 to 40 percent

Surface fragments: about 45 percent medium gravel, about 10 percent cobbles
Depth to restrictive feature: 9 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Permeability: about 0.40 in/hr (moderately slow)
Available water capacity total inches: 1.0
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: very high
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-6
Ecological site name: Limestone Slopes (PIED, JUOS) 13-17" p.z.
Ecosystem site number: 035XF613AZ
Present native vegetation: muttongrass, Artemisia, Stansbury cliffrose, Colorado pinyon, Utah juniper
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau, Havasupai Point; 2,691 feet south of Fossil Mountain; 36 degrees, 10 minutes, 59 seconds north latitude; 112 degrees, 21 minutes, 46 seconds west longitude.

A—0 to 2 inches; dark brown (7.5YR 3/4) very gravelly loam; dark brown (7.5YR 3/3) moist; weak thin platy structure; soft, very friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine vesicular and few fine tubular pores; 40 percent gravel, 5 percent cobble; slightly effervescent, moderately alkaline (pH 8.0); abrupt smooth boundary.

Bw—2 to 7 inches; dark brown (7.5YR 3/3) very gravelly loam; dark brown (7.5YR 3/2) moist; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine and few medium roots; common fine tubular pores; 30 percent gravel, 10 percent cobble; slightly effervescent; moderately alkaline (pH 8.0); clear wavy boundary.

Bt—7 to 11 inches; reddish brown (5YR 5/4) very gravelly clay loam; weak coarse prismatic structure parting to strong fine and medium angular blocky; hard, firm, moderately sticky and moderately plastic; few fine and medium roots; few fine tubular pores; many distinct clay films on faces of peds and lining pores; 35 percent gravel, 10 percent cobble; slightly effervescent; moderately alkaline (pH 8.0); abrupt irregular boundary.

R—11 inches; cherty limestone bedrock.

Range in Characteristics

Clay content (control section): 30 to 35 percent
 Rock fragment content (control section): 35 to 50 percent

Depth to bedrock: 9 to 20 inches

A horizon

Value: 3 through 5 dry, 3 or 4 moist
 Chroma: 3 or 4, dry or moist

Bw horizon

Value: 3 or 4, dry or moist
 Chroma: 3 or 4 dry, 2 or 3 moist
 Clay content: 10 to 18 percent
 Calcium carbonate equivalent: 0 to 5 percent

Bt horizon

Hue: 5YR, 7.5YR
 Value: 4 or 5 dry, 3 or 4 moist
 Chroma: 3 or 4, dry or moist
 Calcium carbonate equivalent: 0 to 5 percent

Some pedons do not have a Bw horizon.

Some pedons developed in limestone or calcareous fine-grained sandstone residuum have a Btk horizon below the Bt horizon.

Some Btk horizons are weakly to moderately cemented with calcium carbonate but do not meet the thickness requirement for a calcic horizon.

Some pedons have a discontinuous, 1-cm to 3-cm-thick fractured, non-root restrictive, weakly to strongly calcium carbonate cemented pan overlying limestone or calcareous fine-grained sandstone bedrock.

Wodmont family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Calcusteptsstona

limestone

SMPS SHUFHQ

Surface fragmentssn:

Depth to restrictive feature:n:

lithic

Drainage class:

about 0.40 in hr

Available water capacity t

Flooding hazardn:

Seasonal water table mini

Major Land Resource Area: 35
Land Resource Unit: 35-6
Ecological site name: Limestone Slopes (PIED, JUOS) 13-17" p.z.
Ecosystem site number: 035XF613AZ
Present native vegetation: muttongrass, Artemisia, Stansbury cliffrose, Colorado pinyon, Utah juniper
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau, Havasupai Point; 3,866 feet southwest of Fossil Mountain; 36 degrees, 10 minutes, 50 seconds north latitude; 112 degrees, 21 minutes, 58 seconds west longitude.

A—0 to 1 inch; yellowish brown (10YR 5/4) very gravelly loam; dark yellowish brown (10YR 4/4) moist; weak thick platy structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; few very fine vesicular and common fine irregular pores; 20 percent gravel, 10 percent cobble, and 5 percent stone; strongly effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bk—1 to 9 inches; brown (7.5YR 4/4) very cobbly loam; dark brown (7.5YR 3/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and few fine and medium roots; common fine tubular pores; few soft filaments of calcium carbonate; 15 percent gravel, 15 percent cobble, and 5 percent stone; violently effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

R—9 inches, limestone bedrock.

Range in Characteristics

Clay content (control section): 12 to 18 percent
 Rock fragment content (control section): 35 to 70 percent
 Depth to bedrock: 7 to 20 inches

A horizon

Hue: 7.5YR, 10YR
 Value: 3 through 5 dry, 3 or 4 moist
 Chroma: 3 or 4, dry or moist

Bk horizon

Hue: 7.5YR, 10YR
 Value: 4 or 5 dry, 3 or 4 moist
 Chroma: 3 or 4, dry or moist
 Calcium carbonate equivalent: 15 to 40 percent
 Some pedons have a Bw horizon above the Bk horizon.

Houserock family soils

Taxonomic classification: Clayey-skeletal, smectitic, mesic Lithic Haplustalfs
Geomorphic position: summits
Parent material: residuum weathered from cherty limestone
Slope: 15 to 40 percent
Surface fragments: about 30 percent medium gravel, about 25 percent cobbles, about 5 percent stones
Depth to restrictive feature: 10 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Permeability: about 0.40 in/hr (moderately slow)
Available water capacity total inches: 1.1
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: very high
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-6
Ecological site name: Clay Loam Upland, Gravelly (PIED, JUOS) 13-17" p.z.
Ecosystem site number: 035XF611AZ
Present native vegetation: muttongrass, Utah juniper, Wyoming big sagebrush, blue grama, Colorado pinyon
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau; 423 feet west of Horsethief Tank; 36 degrees, 2 minutes, 21 seconds north latitude; 112 degrees, 13 minutes, 15 seconds west longitude.

A1—0 to 2 inches; brown (7.5YR 4/4) very cobbly loam; dark brown (7.5YR 3/2) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and common fine roots; common very fine tubular and irregular pores; 15 percent gravel, 20 percent cobble, and 5 percent stone; violently effervescent; slightly alkaline (pH 7.8); abrupt smooth boundary.

Bw—2 to 6 inches; brown (7.5YR 5/3) very cobbly loam; dark brown (7.5YR 3/2) moist; moderate coarse subangular blocky structure parting to moderate medium subangular blocky; slightly hard, friable, moderately sticky and moderately plastic; many very fine and common medium and coarse roots; common fine tubular pores; 20 percent gravel, 15 percent cobble, and 2 percent stone; violently effervescent; moderately alkaline (pH 8.2); abrupt wavy boundary.

Bt—6 to 14 inches; brown (7.5YR 4/4) very cobbly silty clay; brown (7.5YR 4/3) moist; strong very fine and fine angular blocky structure; hard, firm, very sticky and very plastic; common fine through coarse roots; common fine tubular pores; many distinct clay films on faces of peds and lining pores; 25 percent gravel, 20 percent cobble, and 10 percent stone; violently effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

R—14 inches; fractured, cherty limestone bedrock.

Range in Characteristics

Bt1—2 to 5 inches; brown (7.5YR 4/4) cobbly loam; dark brown (7.5YR) moist; weak fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and few fine tubular pores; few faint clay films bridging sand grains and lining pores; 10 percent gravel, 10 percent cobble; noneffervescent; slightly alkaline (pH 7.8); clear wavy boundary.

Bt2—5 to 10 inches; brown (7.5YR 5/4) very cobbly loam; brown (7.5YR 4/4) moist; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and few fine and medium roots; common very fine and few fine tubular pores; common thin clay films bridging sand grains and lining pores and few faint clay films on faces of peds; 25 percent gravel, 15 percent cobble; coarse fragments include 40 percent pan fragments and 60 percent limestone fragments; slightly effervescent; moderately alkaline (pH 8.0); clear wavy boundary

Btk—10 to 15 inches; brown (7.5YR 5/4) very cobbly loam; brown (7.5YR 4/4) moist; moderate very fine and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and few fine through coarse roots; common very fine and fine tubular pores; common faint clay films bridging sand grains and lining pores; few fine soft masses of calcium carbonate; 30 percent gravel, 20 percent cobble; coarse fragments include 40 percent pan fragments and 60 percent limestone fragments; medium and coarse roots are concentrated on top of the lithic contact; strongly effervescent; moderately alkaline (pH 8.2); abrupt wavy boundary.

R—15 inches; slightly weathered, fractured limestone bedrock with a thin, discontinuous, calcium carbonate laminar cap.

Range in Characteristics

Clay content (control section): 20 to 30 percent
Rock fragment content (control section): 35 to 50 percent
Depth: 9 to 20 inches

A horizon

Value: 3 through 6 dry, 3 or 4 moist
Chroma: 4 through 6 dry, 3 or 4 moist

Bt horizon

Hue: 5YR, 7.5YR
Value: 3 through 5 dry, 3 or 4 moist
Chroma: 3 through 5 dry, 3 or 4 moist
Calcium carbonate equivalent: 0 to 5 percent

Bt horizon

Value: 4 through 6 dry, 3 or 4 moist
Chroma: 3 or 4, dry or moist
Calcium carbonate equivalent: 2 to 15 percent

Some pedons have a discontinuous, 1-cm to 3-cm-thick fractured, non-root restrictive, weakly to strongly calcium carbonate cemented pan overlying limestone or calcareous fine-grained sandstone bedrock.

Wodomont family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Calciustepts

Geomorphic position: summits

Parent material: residuum weathered from cherty limestone

Slope: 2 to 15 percent

Surface fragments: about 40 percent gravel, about 5 percent cobbles, about 2 percent stones

Depth to restrictive feature: 7 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 0.8

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: High

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Limestone Upland (JUOS, PIED) 13-17" p.z.

Ecosystem site number: 035XF619AZ

Present native vegetation: Artemisia, Utah juniper, Colorado pinyon, Stansbury cliffrose, green Mormon tea

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On Havasupai Point; 2,259 feet northeast of Chemehuevi Point; 36 degrees, 11 minutes, 4 seconds north latitude; 112 degrees, 23 minutes, 17 seconds west longitude.

A—0 to 1 inch; dark brown (7.5YR 3/4) very gravelly loam; dark brown (7.5 YR 3/3) moist; weak thin platy structure; soft, very friable, nonsticky and nonplastic; many very fine and few fine roots; many very fine vesicular pores; 35 percent gravel, 5 percent cobble; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary;

Bw—1 to 5 inches; dark brown (7.5YR 3/4) very

gravelly loam; dark brown (7.5 YR 3/3) moist; moderate medium subangular blocky structure; slightly hard; friable, slightly sticky and slightly plastic; common fine and medium roots; common fine tubular pores; 30 percent gravel, 10 percent cobble; violently effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bk—5 to 11 inches; light brown (7.5YR 6/4) very gravelly loam; brown (7.5YR 5/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine through coarse roots; common fine tubular pores; common medium soft masses of calcium carbonate; thick calcium carbonate coats and pendants on rock fragments; 30 percent gravel, 10 percent cobble; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

R—11 inches; limestone bedrock.

Range in Characteristics

Clay content (control section): 12 to 18 percent
Rock fragment content (control section): 35 to 70 percent

Reaction: slightly to moderately alkaline
Depth to bedrock: 7 to 20 inches

A horizon

Hue: 7.5YR, 10YR
Value: 3 through 5 dry, 3 or 4 moist
Chroma: 3 or 4, dry or moist

Bw horizon

Hue: 7.5YR, 10YR
Value: 3 through 5 dry, 3 or 4 moist
Chroma: 3 or 4, dry or moist
Calcium carbonate equivalent: 1 to 15 percent

Bk horizon

Hue: 7.5YR, 10YR
Value: 4 through 6 dry, 3 through 5 moist
Chroma: 3 or 4, dry or moist
Effervescence: strongly to violently effervescent
Calcium carbonate equivalent: 15 to 40 percent

Some pedons do not have a Bw horizon.

Toqui family soils

Taxonomic classification: Clayey, smectitic, mesic
Lithic Haplustalfs

Geomorphic position: summits

Parent material: residuum weathered from cherty limestone

Slope: 2 to 15 percent

Surface fragments: about 1 percent stones, about 1 percent cobbles, about 15 percent gravel

Depth to restrictive feature: 8 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.03 in/hr (very slow)

Available water capacity total inches: 2.8

Shrink-swell potential: about 7.0 LEP (high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: High

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Clay Loam Upland, Gravelly (PIED, JUOS) 13-17" p.z.

Ecosystem site number: 035XF611AZ

Present native vegetation: muttongrass, Utah juniper, Wyoming big sagebrush, blue grama, Colorado pinyon

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On Havasupai Point; 4,415 feet southwest of Signal Hill; 36 degrees, 10 minutes, 37 seconds north latitude; 112 degrees, 22 minutes, 11 seconds west longitude.

A—0 to 2 inches; strong brown (7.5YR 4/6) gravelly silt loam; dark brown (7.5YR 3/4) moist; weak thick platy structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; many very fine and fine vesicular pores; 20 percent gravel; slightly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

Btk—2 to 7 inches; brown (7.5YR 4/4) loam; very dark brown (7.5YR 2.5/3) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common fine tubular pores; common faint clay films bridging sand grains; many fine soft seams and filaments of calcium carbonate; 5 percent gravel; strongly effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bt1—7 to 12 inches; reddish brown (5YR 4/4) silty clay; reddish brown (5YR 4/4) moist; moderate coarse prismatic structure parting to strong very fine and fine angular blocky; very hard, very firm; very sticky and very plastic; many fine through coarse roots; many prominent clay films on faces of peds and lining pores;

few continuous pressure faces across faces of peds; 5 percent gravel; violently effervescent; moderately alkaline (pH 8.0); clear wavy boundary.

Bt2—12 to 19 inches; reddish brown (5YR 4/4) cobbly clay; reddish brown (5YR 4/4) moist; moderate coarse prismatic structure parting to strong medium angular blocky; very hard, very firm; very sticky and very plastic; few medium and coarse roots; many prominent clay films on faces of peds and lining pores; few continuous pressure faces across faces of peds; 10 percent gravel, 20 percent cobble; violently effervescent; moderately alkaline (pH 8.0); abrupt irregular boundary.

R—19 inches; cherty limestone bedrock with a 0.5 inch weathering rind.

Range in Characteristics

Depth to bedrock: 8 to 20 inches

A horizon

Hue: 7.5YR, 10YR

Value: 3 through 5 dry, 3 or 4 moist

Chroma: 3 through 6 dry, 2 through 4 moist

Reaction: slightly acid to moderately alkaline

Bt horizon

Hue: 5YR, 7.5YR

Value: 3 through 5 dry, 3 or 4 moist

Chroma: 3 through 6, dry or moist

Rock fragments: averages 0 to 35 percent, mostly gravel

Clay content: averages 35 to 50 percent, may be less in some horizons

Some pedons may have Bk or Btk horizons.

24—Cliffdown, moderately steep- Cliffdown families complex, 15 to 40 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,500 to 4,500 feet (1,067 to 1,372 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 55 to 57 degrees F (13 to 14 degrees C)

Mean annual soil temperature: 57 to 59 degrees F (15 to 16 degrees C)

Frost-free period: 180 to 195 days

Map Unit Composition

Cliffdown family and similar soils: 45 percent

Cliffdown family and similar soils: 30 percent

Minor components: 25 percent

- Soils that have petrocalcic horizons
- Soils in drainageways that are occasionally flooded
- Soils that are shallow to bedrock
- Soils that have accumulation of calcium carbonate in the profile
- Talus slopes devoid of vegetation

Properties and Qualities

Cliffdown family, moderately steep, soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, calcareous, mesic Typic Torriorthents

Geomorphic position: fan terraces on escarpments of plateaus

Parent material: colluvium derived from limestone, sandstone, and shale

Slope: 15 to 50 percent

Surface fragments: about 30 percent coarse gravel, about 5 percent stones, about 30 percent cobbles

Depth to restrictive feature: 40 to 60 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 3.1

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: C

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Slopes 6-10" p.z.

Ecosystem site number: 035XE507AZ

Present native vegetation: black grama, desert needlegrass, blackbrush, blue threeawn, ephedra, Opuntia

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In Bright Angel Canyon; 267 feet southwest of Cottonwood Camp; 36 degrees, 10 minutes, 8 seconds north latitude; 112 degrees, 2 minutes, 30 seconds west longitude.

A—0 to 10 inches; brown (7.5YR 5/4) very cobbly loam; brown (7.5YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and

nonplastic; few very fine and fine roots, few very fine and fine tubular and vesicular pores; 20 percent gravel, 25 percent cobble, and 5 percent stone; slightly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

C1—10 to 40 inches; reddish brown (5YR 5/4) very cobbly loam; reddish brown (5YR 4/4) moist; massive; soft, very friable, slightly sticky and nonplastic; common very fine through medium roots; common fine and medium tubular pores; common thin calcium carbonate coats on the undersides of rocky fragments; 5 percent gravel, 40 percent cobble, and 5 percent stone; strongly effervescent; moderately alkaline (pH 8.4); gradual wavy boundary.

C2—40 to 60 inches; light reddish brown (5YR 6/4) very gravelly loam; reddish brown (5YR 5/4) moist; massive; soft, very friable, slightly sticky and nonplastic; few very fine through medium roots; common fine and medium tubular pores; common thin calcium carbonate coats on the undersides of rocky fragments; 35 percent gravel, 15 percent cobble, and 5 percent stone; strongly effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Clay content: 5 to 15 percent in the particle size control section

Rock fragments: average 35 to 75 percent in the particle size control section

Reaction: moderately alkaline or strongly alkaline.

Effervescence: Slightly effervescent to violently effervescent.

Calcium carbonate equivalent: 15 to 40 percent in the less than 2 millimeter fraction.

Other features: Some pedons have thin Bk horizons with few carbonate coats on pebbles.

A horizon

Hue: 10YR, 7.5YR

Value: 6 or 7 dry, 3 through 5 moist

Chroma: 2 through 4, dry or moist

Cliffdown family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, calcareous, mesic Typic Torriorthents

Geomorphic position: stream terraces in drainageways of side canyons

Parent material: alluvium derived from mixed sources

Slope: 15 to 30 percent

Surface fragments: about 30 percent coarse gravel, about 5 percent stones, about 30 percent cobbles

Depth to restrictive feature: 40 to 60 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 3.0

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Medium

Hydrologic group: C

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Slopes 6-10" p.z.

Ecosystem site number: 035XE507AZ

Present native vegetation: black grama, desert needlegrass, blackbrush, blue threeawn, ephedra, Opuntia

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In Bright Angel Canyon; 267 feet southwest of Cottonwood Camp; 36 degrees, 10 minutes, 8 seconds north latitude; 112 degrees, 2 minutes, 30 seconds west longitude.

A—0 to 2 inches; yellowish brown (10YR 5/4) extremely cobbly loam, dark yellowish brown (10YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; common very fine through medium tubular pores; 45 percent gravel, 20 percent cobble; 10 percent stone; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

C1—2 to 10 inches; light yellowish brown (10YR 6/4) very cobbly loam, dark yellowish brown (10YR 4/4) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine and common medium and coarse roots; common fine and medium tubular and few coarse tubular pores; 25 percent gravel, 20 percent cobble; violently effervescent; moderately alkaline (pH 8.2); clear irregular boundary.

C2—10 to 30 inches; light yellowish brown (10YR 6/4) extremely gravelly loam, yellowish brown (10YR 5/4) moist; weak fine subangular blocky structure; soft, very friable, moderately sticky and moderately plastic; common very fine through coarse roots; common fine through coarse tubular pores; 55 percent gravel, 10 percent cobble; violently effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

C3—30 to 60 inches; light yellowish brown (10YR 6/4) extremely gravelly sandy loam; yellowish brown (10YR 5/4) moist; weak fine subangular blocky structure; soft, very friable, moderately sticky and moderately plastic;

common very fine through coarse roots; common fine through coarse tubular pores; 55 percent gravel, 10 percent cobble; violently effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

Range in Characteristics

Clay content: 5 to 15 percent in the particle size control section

Rock fragments: average 35 to 75 percent in the particle size control section

Reaction: moderately alkaline or strongly alkaline

Effervescence: Slightly effervescent to violently effervescent

Calcium carbonate equivalent: 15 to 40 percent in the less than 2 millimeter fraction

Other features: Some pedons have thin Bk horizons with few carbonate coats on pebbles.

A horizon

Hue: 10YR, 7.5YR

Value: 6 or 7 dry, 3 through 5 moist

Chroma: 2 through 4, dry or moist

25—Cliffdown-Izo families complex, 2 to 8 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,500 to 4,500 feet (1,067 to 1,372 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 55 to 57 degrees F (13 to 14 degrees C)

Mean annual soil temperature: 57 to 59 degrees F (15 to 16 degrees C)

Frost-free period: 180 to 195 days

Map Unit Composition

Cliffdown family and similar soils: 50 percent

Izo family and similar soils: 35 percent

Minor components: 15 percent

- Soils that have petrocalcic horizons
- Soils in drainageways that are occasionally flooded
- Soils that are shallow to bedrock
- Soils that have accumulation of calcium carbonate in the profile
- Talus slopes devoid of vegetation

Properties and Qualities

Cliffdown family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, calcareous, mesic Typic Torriorthents

Geomorphic position: stream terraces of perennial creeks in side canyons

Parent material: alluvium derived from mixed sources

Slope: 2 to 8 percent

Surface fragments: about 30 percent cobbles, about 30 percent coarse gravel, about 5 percent stones

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 3.2

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Medium

Hydrologic group: C

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Sandy Loam Terrace 6-10" p.z.

Ecosystem site number: 035XE513AZ

Present native vegetation: Apache plume, Opuntia, catclaw acacia, sand dropseed, ephedra

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In Bright Angel Canyon; 267 feet southwest of Cottonwood Camp; 36 degrees, 10 minutes, 8 seconds north latitude; 112 degrees, 2 minutes, 30 seconds west longitude.

A—0 to 1 inch; brown (7.5YR 5/4) extremely cobbly loam; brown (7.5YR 4/4) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; few very fine and fine roots, few fine tubular pores; 20 percent gravel, 40 percent cobble, and 5 percent stone; slightly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

C1—1 to 5 inches; brown (7.5YR 5/4) extremely cobbly loam; brown (7.5YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and nonplastic; few very fine and fine roots, few very fine and fine tubular and vesicular pores; 40 percent gravel, 35 percent cobble, and 5 percent stone; slightly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

C2—5 to 30 inches; reddish brown (5YR 5/4) extremely gravelly loam; reddish brown (5YR 4/4) moist; massive; soft, very friable, slightly sticky and nonplastic; common very fine through medium roots; common fine and medium tubular pores; common thin calcium carbonate coats on the undersides of rock fragments; 60 percent gravel, 5 percent cobble, 5 percent stone; strongly effervescent; moderately alkaline (pH 8.4); gradual wavy boundary.

C3—30 to 60 inches; light reddish brown (5YR 6/4) extremely stony loam; reddish brown (5YR 5/4) moist; massive; soft, very friable, slightly sticky and nonplastic; few very fine through medium roots; common fine and medium tubular pores; common thin calcium carbonate coats on the undersides of rock fragments; 40 percent gravel, 10 percent cobble, and 20 percent stone; strongly effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Clay content: 5 to 15 percent in the particle size control section

Rock fragments: average 35 to 75 percent in the particle size control section

Reaction: moderately alkaline or strongly alkaline

Effervescence: Slightly effervescent to violently effervescent

Calcium carbonate equivalent: 15 to 40 percent in the less than 2 millimeter fraction

Other features: Some pedons have thin Bk horizons with few carbonate coats on pebbles.

A horizon

Hue: 10YR, 7.5YR

Value: 6 or 7 dry, 3 through 5 moist

Chroma: 2 through 4, dry or moist

Izo family soils

Taxonomic classification: sandy-skeletal, mixed, mesic Typic Torriorthents

Geomorphic position: flood plains of perennial creeks in side canyons

Parent material: alluvium derived from mixed sources

Slope: 2 to 8 percent

Surface fragments: about 5 percent cobbles, about 50 percent coarse gravel

Drainage class: Excessively drained

Permeability: about 13.00 in/hr (rapid)

Available water capacity total inches: 1.8

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: Occasional

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very low

Hydrologic group: A

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Sandy Bottom, Subirrigated 6-10" p.z.

Ecosystem site number: 035XE512AZ

Present native vegetation: China tamarisk, seepwillow baccharis, arrowweed, desert broom baccharis, other deciduous trees, catclaw acacia, honey mesquite

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In Bright Angel Canyon; 533 feet north of North Kaibab Trail; 36 degrees, 10 minutes, 15 seconds north latitude; 112 degrees, 2 minutes, 24 seconds west longitude.

C1—0 to 13 inches; light brown (7.5YR 6/4) very gravelly loamy sand, brown (7.5YR 4/4) moist; single grain; loose, nonsticky and nonplastic; few very fine roots; many very fine irregular pores; 35 percent gravel, 5 percent cobble; slightly effervescent; slightly alkaline (pH 7.8); gradual wavy boundary.

C2—13 to 60 inches; stratified light brown (7.5YR 6/4) extremely gravelly loamy sand to extremely stony coarse sand, brown (7.5YR 4/4) moist; single grain; loose, nonsticky and nonplastic; few very fine and fine roots; many very fine irregular pores; 70 percent gravel; slightly effervescent; slightly alkaline (pH 7.8).

Range in Characteristics

Rock fragments: average 50 to 75 percent in the particle size control section

Reaction: moderately alkaline or strongly alkaline, commonly increasing with depth

Effervescence: Slightly effervescent or strongly effervescent. Individual thin strata are noneffervescent in some pedons.

A horizon

Value: 6 or 7 dry, 4 or 5 moist

Chroma: 3 or 4

Other features: This horizon commonly is structureless or has finely stratified rock structure and does not qualify as an ochric epipedon

C horizon

Hue: 10YR, 2.5Y

Value: 6 or 7 dry, 4 or 5 moist

Chroma: 2 through 4

Identifiable secondary carbonates: Some pedons have

up to 50 percent of the undersides of rock fragments in any subhorizon covered with thin lime coats.

26—Curhollow-Lapoint-Mellenthin families complex, 2 to 15 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,500 to 6,000 feet (1,372 to 1,829 meters)

Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)

Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)

Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)

Frost-free period: 145 to 160 days

Map Unit Composition

Curhollow and similar soils: 45 percent

Lapoint family and similar soils: 25 percent

Mellenthin family and similar soils: 20 percent

Minor components: 10 percent

- Soils that are moderately deep or deep to bedrock
- Soils that have less than 35 percent by volume rock fragments in the profile
- Soils in drainageways that are subject to occasional flooding
- Rock outcrop

Properties and Qualities

Curhollow family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic, shallow Calcic Petrocalcids

Geomorphic position: summits and sideslopes of low hills and ridges

Parent material: residuum weathered from limestone

Slope: 2 to 15 percent

Surface fragments: about 50 percent coarse gravel

Depth to restrictive feature: 10 to 20 inches to petrocalcic; 30 to 40 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 1.6

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Shallow Loamy 10-14" p.z.

Ecosystem site number: 035XC319AZ

Present native vegetation: Wyoming big sagebrush, blue grama, galleta, ephedra, bottlebrush squirreltail

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Kanab Plateau, Kanab Point; 3,969 feet southwest of Jewel Spring; 36 degrees, 24 minutes, 9 seconds north latitude; 112 degrees, 40 minutes, 16 seconds west longitude.

A—0 to 2 inches; strong brown (7.5YR 4/6) very gravelly loam; dark brown (7.5YR 3/4) moist; moderate medium platy structure; soft, very friable, moderately sticky and moderately plastic; few very fine roots; many very fine and fine vesicular and common fine interstitial pores; 50 percent gravel; strongly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

Bw—2 to 8 inches; brown (7.5YR 4/4) very gravelly loam; dark brown (7.5YR 3/4) moist; weak coarse subangular blocky structure parting to strong very fine and fine subangular blocky; soft, very friable, moderately sticky and slightly plastic; many very fine through medium roots; common very fine and fine tubular and few fine interstitial pores; 40 percent gravel; violently effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bk1—8 to 13 inches; brown (7.5YR 5/4) very gravelly loam; brown (7.5YR 4/4) moist; weak medium subangular blocky structure parting to moderate fine subangular blocky; slightly hard, friable, moderately sticky and slightly plastic; common fine roots; common fine tubular pores; common very fine soft filaments of calcium carbonate; continuous thick calcium carbonate coats and pendants on rock fragments; 35 percent gravel, 10 percent cobble; violently effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

Bk2—14 to 18 inches; brown (7.5YR 5/4) extremely cobbly loam; brown (7.5YR 4/4) moist; moderate fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few fine roots; few fine tubular pores; few very fine soft filaments and masses of calcium carbonate; 25 percent gravel, 50 percent cobble-sized pan fragments; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

Bkm—17 to 30 inches; indurated petrocalcic horizon.

R—30 inches; limestone bedrock

Range in Characteristics

Clay content (control section): 14 to 18 percent
 Rock fragment content (control section): 35 to 75 percent, mostly gravel
 Depth to petrocalcic: 10 to 20 inches
 Depth to bedrock: 15 to 40 inches

A horizon

Value: 4 or 5 dry, 3 or 4 moist
 Chroma: 5 or 6 dry, 3 or 4 moist

Bk horizon

Value: 4 or 5 dry, 3 or 4 moist
 Chroma: 4 through 6 dry, 3 or 4 moist
 Calcium carbonate equivalent: 15 to 30 percent

Some pedons do not have a Bw horizon above the Bk horizon.

Lapoint family soils

Taxonomic classification: Fine-loamy, mixed, superactive, mesic Ustalfic Petrocalcids

Geomorphic position: summits and sideslopes of low hills and ridges

Parent material: residuum weathered from calcareous sandstone

Slope: 2 to 8 percent

Surface fragments: about 10 percent gravel

Depth to restrictive feature: 21 to 40 inches to petrocalcic

Drainage class: Well drained

Permeability: about 0.40 in/hr (moderately slow)

Available water capacity total inches: 2.9

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: High

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Loamy Upland 10-14" p.z.

Ecosystem site number: 035XC313AZ

Present native vegetation: Wyoming big sagebrush, blue grama, galleta, Nevada Mormon tea, Opuntia, bottlebrush squirreltail

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Kanab Plateau, Kanab Point; 4,806 feet north of Jewel Spring; 36 degrees, 24 minutes, 20 seconds north latitude; 112 degrees, 40 minutes, 11 seconds west longitude.

A—0 to 2 inches; strong brown (7.5YR 4/6) gravelly silt loam; brown (7.5YR 4/4) moist; weak thin platy

structure; soft, very friable, moderately sticky and slightly plastic; common very fine roots; common very fine tubular pores; 15 percent gravel; noneffervescent; neutral (pH 7.2); abrupt wavy boundary.

Bt—2 to 12 inches; reddish brown (5YR 4/4) silty clay loam; reddish brown (5YR 4/4) moist; moderate medium prismatic structure parting to strong fine and medium subangular blocky; hard, firm, very sticky and moderately plastic; common fine roots; common fine tubular pores; many faint clay films lining pores and on the faces of peds; 10 percent gravel; slightly effervescent; slightly alkaline (pH 7.6); clear wavy boundary.

Btk—12 to 22 inches; pink (7.5YR 7/4) gravelly clay loam; brown (7.5YR 5/4) moist; moderate medium subangular blocky structure; hard, firm, very sticky and moderately plastic; few fine roots, few fine tubular pores; common faint clay films bridging sand grains; weakly cemented by calcium carbonate; 20 percent gravel; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

Bkm—22 inches; indurated petrocalcic horizon.

Range in Characteristics

Depth to calcic horizon: 7 to 20 inches

Depth to petrocalcic horizon: 21 to 40 inches

Particle size control section: 20 to 35 percent clay and 15 to 35 percent rock fragments

A horizon

Hue: 5YR, 7.5YR, 10YR

Value: 4 through 6 dry, 3 through 5 moist

Chroma: 2 through 6, dry and moist

Btk horizon

Hue: 5YR, 7.5YR

Value: 5, through 7 dry, 4 or 5 moist

Chroma: 4 through 6, dry or moist

Calcium carbonate equivalent: 15 to 20 percent

Mellenthin family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Ustic Haplocalcids

Geomorphic position: summits and sideslopes of low hills and ridges

Parent material: colluvium and/or residuum weathered from limestone

Slope: 2 to 15 percent

Surface fragments: about 60 percent coarse gravel

Depth to restrictive feature: 10 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 1.5
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: very high
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-3
Ecological site name: Shallow Loamy 10-14" p.z.
Ecosystem site number: 035XC319AZ
Present native vegetation: Wyoming big sagebrush, blue grama, galleta, ephedra, bottlebrush squirreltail
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Kanab Plateau, Kanab Point; 4,248 feet north of Jewel Spring; 36 degrees, 24 minutes, 14 seconds north latitude; 112 degrees, 40 minutes, 12 seconds west longitude.

A—0 to 1 inch; variegated (7.5YR 5/4 and 5/6) very gravelly loam; variegated (7.5YR 4/4 and 4/6) moist; strong thin platy structure; slightly hard, very friable, slightly sticky and nonplastic; few very fine and fine roots; few very fine vesicular and common fine tubular pores; 55 percent gravel; strongly effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bw—1 to 3 inches; brown (7.5YR 5/4) very gravelly sandy loam; dark brown (7.5YR 3/4) moist; weak thin platy structure parting to strong very fine subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and fine roots; few very fine tubular pores; 50 percent gravel, 5 percent cobble; violently effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

Bk1—3 to 13 inches; brown (7.5YR 5/4) very stony sandy loam; dark brown (7.5YR 3/4) moist; weak very fine and fine subangular blocky structure parting to single grain; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and fine and few medium and coarse roots; many very fine interstitial and few very fine tubular pores; thin calcium carbonate coats and pendants on the undersides and sides of rock fragments; 15 percent gravel, 15 percent cobble, and 20 percent stone; violently effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

Bk2—13 to 19 inches; pink (7.5YR 7/4) very stony sandy loam; brown (7.5YR 5/4) moist; weak very fine and fine subangular blocky structure parting to single grain; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and fine and few

medium and coarse roots; many very fine interstitial pores; common soft filaments of calcium carbonate; thin calcium carbonate coats and pendants on the undersides and sides of rock fragments; 15 percent gravel, 15 percent cobble, and 20 percent stone; violently effervescent; strongly alkaline (pH 8.6); abrupt wavy boundary.

R—19 inches; fractured calcareous sandstone

Range in Characteristics

Clay content (control section): 15 to 18 percent
 Rock fragment content (control section): 35 to 75 percent
 Depth to calcic horizon: 5 to 13 inches
 Depth to bedrock: 10 to 20 inches

A horizon

Chroma: 4 through 6, dry or moist
 Effervescence: slightly to strongly effervescent

Bk horizon

Value: 4 through 7 dry, 3 through 6 moist
 Chroma: 4 through 6, dry or moist
 Calcium carbonate equivalent: 15 to 25 percent

Some pedons do not have a Bw horizon.

Some calcic horizons are weakly to moderately cemented with calcium carbonate but do not meet the requirements for a petrocalcic horizon.

Some pedons have a discontinuous, 1-cm to 3-cm thick, fractured, non-root restrictive, weakly to strongly calcium carbonate cemented laminar pan overlying limestone or calcareous fine-grained sandstone bedrock.

27—Curhollow-Mellenthin complex, 2 to 25 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,200 to 5,400 feet (1,585 to 1,645 meters)

Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)

Mean annual air temperature: 52 to 54 degrees F (11 to 13 degrees C)

Mean annual soil temperature: 54 to 56 degrees F (13 to 15 degrees C)

Frost-free period: 145 to 150 days

Map Unit Composition

Curhollow and similar soils: 65 percent
 Mellenthin and similar soils: 20 percent
 Minor components: 15 percent

- Rock outcrop of the Kaibab Formation
- Natank soils
- Soils more than 20 inches deep to limestone bedrock
- Soils on steeper slopes
- Soils that have a cobbly surface phase

Properties and Qualities

Curhollow soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic, shallow Calcic Petrocalcids

Geomorphic position: depressions

Parent material: residuum weathered from limestone

Slope: 2 to 8 percent

Surface fragments: about 70 percent coarse gravel

Depth to restrictive feature: 10 to 20 inches to petrocalcic; 15 to 25 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 1.4

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Medium

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Shallow Loamy 10-14" p.z.

Ecosystem site number: 035XC319AZ

Present native vegetation: Wyoming big sagebrush, blue grama, galleta, ephedra, bottlebrush squirreltail

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Kanab Plateau, Whitmore Point, 1.40 miles south of Whitmore Point Pond; 36 degrees, 14 minutes, 59 seconds north latitude; 113 degrees, 17 minutes, 28 seconds west longitude.

A—0 to 2 inches; brown (7.5YR 5/4) very gravelly fine sandy loam; dark brown (7.5YR 3/4) moist; weak fine platy structure parting to moderate very fine granular; soft, very friable, slightly sticky and slightly plastic; few very fine roots; common very fine tubular pores; 40 percent gravel; strongly effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bw—2 to 7 inches; brown (7.5YR 5/4) gravelly loam; dark brown (7.5YR 3/4) moist; strong fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and fine and few fine through coarse roots; many fine and medium tubular pores; 20 percent gravel; violently

effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bk—7 to 15 inches; brown (7.5YR 5/4) very gravelly silt loam; dark brown (7.5YR 3/4) moist; moderate fine and medium subangular blocky structure; soft, very friable, moderately sticky and slightly plastic; few fine through coarse roots; common very fine and few fine tubular pores; 40 percent gravel; many thick calcium carbonate coatings and pendants on the undersides of rock fragments; violently effervescent, moderately alkaline (pH 8.4); abrupt smooth boundary.

Bkm—15 to 22 inches; petrocalcic with indurated laminar cap.

R—22 inches; limestone bedrock.

Range in Characteristics

Depth to calcic: 2 to 9 inches

Depth to petrocalcic horizon: 10 to 20 inches

Depth to bedrock: 15 to 25 inches

Clay content (control section): 18 to 25 percent

Rock fragment content (control section): 35 to 60 percent

A horizon

Hue: 7.5YR, 10YR

Value: 5 or 6 dry, 3 or 4 moist

Chroma: 3 or 4, dry or moist

Calcium carbonate equivalent: 5 to 10 percent

Bw horizons

Hue: 7.5YR, 10YR

Value: 5 or 6 dry, 3 or 4 moist

Chroma: 3 or 4, dry or moist

Calcium carbonate equivalent: 5 to 10 percent

Rock fragments: 20 to 30 percent

May not be present in some pedons.

Bk horizons

Hue: 7.5YR, 10YR

Value: 5 or 6 dry, 3 through 5 moist

Chroma: 4 through 6, dry or moist

Calcium carbonate equivalent: 10 to 25 percent

Rock fragments: 35 to 65 percent

Mellenthin soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Ustic Haplocalcids

Geomorphic position: summits of ridges and escarpments

Parent material: colluvium and/or residuum weathered from limestone

Slope: 2 to 25 percent

Surface fragments: about 10 percent cobbles, about 50 percent coarse gravel, about 5 percent stones
Depth to restrictive feature: 8 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Permeability: about 1.30 in/hr (moderate)
Available water capacity total inches: 0.9
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: very high
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-3
Ecological site name: Shallow Loamy 10-14" p.z.
Ecosystem site number: 035XC319AZ
Present native vegetation: Wyoming big sagebrush, blue grama, galleta, ephedra, bottlebrush squirreltail
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Kanab Plateau, Whitmore Point, 1.45 miles south of Whitmore Point Pond; 36 degrees, 14 minutes, 57 seconds north latitude; 113 degrees, 17 minutes, 24 seconds west longitude.

A—0 to 2 inches; brown (7.5YR 5/4) very gravelly loam; brown (7.5YR 4/4) moist; weak medium platy structure parting to moderate fine granular; soft, very friable, slightly sticky and slightly plastic; few very fine roots; few very fine tubular and many very fine and fine irregular pores; 45 percent gravel, 10 percent cobble, 2 percent stone; strongly effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bk1—2 to 5 inches; brown (7.5YR 4/4) very gravelly loam; dark brown (7.5YR 3/4) moist; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine and coarse and common fine and medium tubular pores; 25 percent gravel, 10 percent cobble, 2 percent stone; violently effervescent; moderately alkaline (pH 8.4); abrupt wavy boundary.

Bk2—5 to 11 inches; brown (7.5YR 4/4) very gravelly loam; brown (7.5YR 3/4) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and few fine through coarse roots; common very fine and fine tubular pores; 35 percent gravel, 12 percent flagstone; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

R—11 inches; limestone bedrock.

Range in Characteristics

Depth to bedrock: 8 to 20 inches
 Clay content: 10 to 15 percent in the particle size control section
 Rock fragments: average 35 to 60 percent gravel, cobble, and stone in the particle size control section

A horizon

Hue: 7.5YR, 5YR
 Value: 5 or 6 dry, 3 or 4 moist
 Chroma: 3 or 4, dry or moist
 Calcium carbonate equivalent: 5 to 20 percent

Bk horizons

Hue: 7.5YR, 5YR
 Value: 4 through 6 dry, 3 or 4 moist
 Chroma: 3 or 4, dry or moist
 Calcium carbonate equivalent: 15 to 25 percent

28—Curhollow-Meriwhitica complex, 2 to 25 percent slopes

Map Unit Setting

Landform: plateau
Elevation: 5,200 to 5,400 feet (1,584 to 1,645 meters)
Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)
Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)
Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)
Frost-free period: 145 to 150 days

Map Unit Composition

Curhollow and similar soils: 65 percent
 Meriwhitica and similar soils: 20 percent
 Minor components: 15 percent

- Rock outcrop
- Natank soils
- Soils more than 20 inches deep to limestone bedrock
- Soils that have a cobbly surface phase
- Soils on steeper slopes

Properties and Qualities

Curhollow soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic, shallow Calcic Petrocalcids
Geomorphic position: depressions
Parent material: residuum weathered from limestone

Slope: 2 to 8 percent
Surface fragments: about 30 percent coarse gravel
Depth to restrictive feature: 10 to 20 inches to petrocalcic; 15 to 25 inches to bedrock (lithic)
Drainage class: Well drained
Permeability: about 1.30 in/hr (moderate)
Available water capacity total inches: 1.3
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: Medium
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-3
Ecological site name: Shallow Loamy 10-14" p.z.
Ecosystem site number: 035XC319AZ
Present native vegetation: Wyoming big sagebrush, blue grama, galleta, ephedra, bottlebrush squirreltail
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Kanab Plateau, Whitmore Point, 1.03 miles east of Keyhole Dam; 36 degrees, 12 minutes, 23 seconds north latitude; 113 degrees, 16 minutes, 5 seconds west longitude.

A—0 to 3 inches; brown (7.5YR 5/4) gravelly loam; dark brown (7.5YR 3/4) moist; weak medium platy structure parting to moderate fine granular; soft, very friable, slightly sticky and moderately plastic; few very fine roots; many very fine irregular pores; 25 percent gravel; violently effervescent; moderately alkaline (pH 8.4); abrupt wavy boundary.

Bw—3 to 7 inches; brown (7.5YR 5/4) gravelly loam; dark brown (7.5YR 3/4) moist; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and moderately plastic; common very fine and few fine and medium roots; common very fine and fine and few medium and coarse tubular pores; 25 percent gravel consisting of pan fragments and rounded chert nodules; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bk—7 to 13 inches; brown (7.5YR 5/4) very gravelly silt loam; dark brown (7.5YR 3/4) moist; strong fine subangular blocky structure; slightly hard, very friable, moderately sticky and moderately plastic; common very fine and few fine through coarse roots; common very fine and few fine tubular pores; 50 percent gravel consisting of pan fragments and rounded chert nodules; common fine calcium carbonate coatings on rock fragments and common moderately thick calcium

carbonate coatings on the undersides of rock fragments; violently effervescent, moderately alkaline (pH 8.4); abrupt smooth boundary.

Bkm—13 to 18 inches; fractured petrocalcic with an extremely thin (less than 1-millimeter-thick) laminar cap; fractures contain roots and are more than 4 inches apart.

R—18 inches; limestone bedrock.

Range in Characteristics

Depth to thin petrocalcic horizon: 10 to 20 inches
 Depth to bedrock: 15 to 25 inches to a lithic contact
 Control section: Clay content averages 18 to 25 percent; fine sand or coarser content: 40 to 60 percent; Rock fragments: 35 to 90 percent, mainly pebbles and cobbles. Lithology of fragments is typically sedimentary rocks such as limestone or sandstone

Reaction: Slightly alkaline to strongly alkaline

A horizon

Hue: 5YR through 10YR
 Value: 4 or 6 dry, 3 or 4 moist
 Chroma: 2 through 6, dry or moist

Bk horizons

Hue: 5YR through 10YR
 Value: 4 through 8 dry, 3 through 7 moist
 Chroma: 3 through 6, dry or moist
 Rock fragments: 35 to 90 percent, mainly pebbles and cobbles
 Identifiable secondary carbonates: Carbonates commonly coat undersides of rock fragments, but may be disseminated in the horizon matrix.
 Effervescence: Strongly effervescent or violently effervescent
 Calcium carbonate equivalent: 15 to 30 percent

Meriwhitica soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, calcareous, mesic Lithic Ustic Torriorthents

Geomorphic position: summits of ridges and escarpments

Parent material: colluvium and/or residuum weathered from limestone

Slope: 2 to 25 percent

Surface fragments: about 70 percent coarse gravel

Depth to restrictive feature: 4 to 10 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 0.4

Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: very high
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-3
Ecological site name: Shallow Upland, Calcareous 10-14" p.z.
Ecosystem site number: 035XC331AZ
Present native vegetation: blackbrush, ephedra, desert needlegrass, galleta, Stansbury cliffrose, banana yucca
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Kanab Plateau, Whitmore Point, 4,867 feet east of Keyhole Dam; 36 degrees, 12 minutes, 10 seconds north latitude; 113 degrees, 16 minutes, 15 seconds west longitude.

A—0 to 2 inches; light brown (7.5YR 6/4) extremely gravelly loam; brown (7.5YR 4/4) moist; moderate fine subangular blocky structure parting to moderate fine granular; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; many very fine and fine irregular and common fine and medium tubular pores; 65 percent gravel, 5 percent cobble; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bk—2 to 7 inches; light brown (7.5YR 6/4) extremely cobbly silt loam; brown (7.5YR 4/4) moist; moderate fine and medium subangular blocky structure; hard, friable, moderately sticky and moderately plastic; common very fine through medium roots; common very fine and fine tubular pores; 30 percent gravel, 35 percent cobble; common moderately thick calcium carbonate pendants on the undersides of coarse fragments; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

R—7 inches; limestone bedrock.

Range in Characteristics

Depth to bedrock: 4 to 10 inches
 Clay content: 10 to 15 percent
 Rock fragments: 60 to 85 percent in the particle size control section
 Calcium carbonate equivalent: 20 to 35 percent

A horizon

Hue: 7.5YR, 10YR
 Value: 5 or 6 dry, 4 or 5 moist

Chroma: 3 or 4, dry or moist

Bk horizon

Hue: 7.5YR, 10YR
 Value: 5 or 6 dry, 4 or 5 moist
 Chroma: 3 or 4, dry or moist

29—Curhollow-Puertecito complex, 1 to 12 percent slopes

Map Unit Setting

Landform: plateau
Elevation: 4,600 to 6,500 feet (1,402 to 1,981 meters)
Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)
Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)
Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)
Frost-free period: 145 to 175 days

Map Unit Composition

Curhollow and similar soils: 55 percent
 Puertecito and similar soils: 30 percent
 Minor components: 15 percent

- Deep soils in drainageways
- Rock outcrop
- Soils that are deeper than 20 inches

Properties and Qualities

Curhollow soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic, shallow Calcic Petrocalcids
Geomorphic position: summits
Parent material: colluvium derived from limestone
Slope: 1 to 12 percent
Depth to restrictive feature: 15 to 25 inches to bedrock (lithic); 10 to 20 inches to petrocalcic
Drainage class: Well drained
Permeability: about 1.30 in/hr (moderate)
Available water capacity total inches: 0.9
Shrink-swell potential: about 1.5 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: Medium
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-3
Ecological site name: Shallow Loamy 10-14" p.z.
Ecosystem site number: 035XC319AZ

Present native vegetation: Wyoming big sagebrush, blue grama, galleta, ephedra, bottlebrush squirreltail

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau, about 1,950 feet north and 2,300 feet west of the southeast corner of section 21, township 30 north, range 6 west, 35 degrees, 58 minutes, 4.3 seconds north latitude; 112 degrees, 55 minutes, 56.3 seconds west longitude.

A—0 to 1 inch; yellowish brown (10YR 5/4) very gravelly loam; dark brown (10YR 4/3) moist; weak thick platy structure; soft, very friable, nonsticky and nonplastic; many very fine roots; common very fine vesicular pores; 50 percent gravel; noneffervescent; slightly alkaline (pH 7.4); clear smooth boundary.

Bk1—1 to 4 inches; dark yellowish brown (10YR 4/4) gravelly loam; dark brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; many very fine soft calcium carbonate masses and thin coatings on rock fragments; 35 percent gravel; strongly effervescent; slightly alkaline (pH 7.8); clear smooth boundary.

Bk2—4 to 11 inches; dark brown (10YR 4/3) very cobbly loam; dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; few very fine tubular pores; 25 percent gravel, 30 percent cobble; common thick calcium carbonate pendants on undersides of rock fragments; violently effervescent; slightly alkaline (pH 7.6); abrupt smooth boundary.

Bkm—11 to 20 inches; indurated petrocalcic horizon; abrupt smooth boundary.

R—20 inches; limestone bedrock.

Range in Characteristics

Clay content (control section): 18 to 27 percent
Rock fragment content (control section): 35 to 75 percent

Reaction: slightly to moderately alkaline

Bk horizon

Clay content: 20 to 27 percent

Calcium carbonate equivalent: 15 to 40 percent

Puertecito soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Ustic Haplargids

Geomorphic position: summits

Parent material: colluvium derived from limestone

Slope: 1 to 12 percent

Depth to restrictive feature: 8 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.40 in/hr (moderately slow)

Available water capacity total inches: 1.2

Shrink-swell potential: about 4.5 LEP (moderate)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Medium

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Limy Upland 10-14" p.z.

Ecosystem site number: 035XC311AZ

Present native vegetation: needleandthread, Indian ricegrass, Nevada Mormon tea, Wyoming big sagebrush, black grama, blue grama, fourwing saltbush

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau, about 1,750 feet north and 2,200 feet west of the southeast corner of section 21, township 29 north, range 7 west; 35 degrees, 52 minutes, 49 seconds north latitude; 113 degrees, 2 minutes, 9 seconds west longitude.

A—0 to 2 inches; yellowish brown (10YR 5/4) very gravelly loam; dark yellowish brown (10YR 4/4) moist; weak thick platy structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many very fine vesicular pores; 50 percent gravel; noneffervescent; neutral (pH 7.1); abrupt smooth boundary.

Bt1—2 to 6 inches; brown (7.5YR 4/4) very gravelly clay loam; dark brown (7.5YR 3/3) moist; weak fine subangular blocky structure; hard, friable, moderately sticky and moderately plastic; many very fine roots; common very fine tubular pores; few faint clay films bridging sand grains and on faces of peds; 35 percent gravel; noneffervescent; neutral (pH 7.0); clear smooth boundary.

Bt2—6 to 10 inches; brown (7.5YR 4/4) very gravelly clay loam; dark brown (7.5YR 3/3) moist; weak fine subangular blocky structure; hard, firm, moderately sticky and moderately plastic; common very fine roots; common very fine tubular pores; few faint clay films bridging sand grains and on faces of peds; few thick calcium carbonate pendants on the undersides of rock

fragments; 50 percent gravel; noneffervescent; neutral (pH 7.1); clear smooth boundary.

Bt3—10 to 13 inches; brown (7.5YR 4/3) very gravelly loam; dark brown (7.5YR 3/3) moist; weak fine subangular blocky structure; hard, friable, moderately sticky and moderately plastic; common very fine roots; common very fine tubular pores; few faint clay films bridging sand grains and on faces of peds; common thin calcium carbonate coatings on the undersides of rock fragments; 55 percent gravel; strongly effervescent; neutral (pH 7.2); abrupt smooth boundary.

2R—13 inches; cherty limestone bedrock.

Range in Characteristics

Rock fragment content (control section): 35 to 55 percent, with less than 10 percent cobbles

Bt horizon

Texture: loam, clay loam (gravelly or very gravelly)

Btk horizon

Calcium carbonate equivalent: 8 to 15 percent

30—Curhollow-Puertecito-Mellenthin families complex, 2 to 25 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,500 to 6,000 feet (1,372 to 1,829 meters)

Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)

Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)

Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)

Frost-free period: 145 to 160 days

Map Unit Composition

Curhollow and similar soils: 45 percent

Puertecito family and similar soils: 30 percent

Mellenthin family and similar soils: 20 percent

Minor components: 5 percent

- Soils that are moderately deep or deep to bedrock
- Soils that have less than 35 percent by volume rock fragments in the profile
- Soils in drainageways that are subject to occasional flooding
- Rock outcrop

Properties and Qualities

Curhollow soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic, shallow Calcic Petrocalcids

Geomorphic position: summits and sideslopes of low hills and ridges

Parent material: residuum weathered from limestone

Slope: 2 to 8 percent

Surface fragments: about 70 percent coarse gravel

Depth to restrictive feature: 7 to 20 inches to petrocalcic; 15 to 25 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 0.9

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: High

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Shallow Loamy 10-14" p.z.

Ecosystem site number: 035XC319AZ

Present native vegetation: Wyoming big sagebrush, blue grama, galleta, ephedra, bottlebrush, squirreltail

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Kanab Plateau, between SB and Kanab Points; 2.46 miles northeast of Buckhorn Spring; 36 degrees, 24 minutes, 26 seconds north latitude; 112 degrees, 44 minutes, 51 seconds west longitude.

A1—0 to 1 inch; brown (7.5YR 5/4) extremely gravelly loam; dark brown (7.5YR 3/4) moist; moderate thin and medium platy structure; soft, very friable; nonsticky and slightly plastic; few very fine and fine roots; many very fine and few fine vesicular pores; 75 percent gravel, 5 percent cobble; strongly effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

AB—1 to 3 inches; brown (7.5YR 5/4) extremely gravelly loam; dark brown (7.5YR 3/4) moist; weak medium platy structure parting to moderate very fine and fine subangular blocky; soft, very friable; nonsticky and slightly plastic; few very fine and fine roots; common very fine vesicular and tubular pores; 55 percent gravel, 5 percent cobble; strongly

effervescent; moderately alkaline (pH 8.4); abrupt wavy boundary.

Bk1—3 to 6 inches; brown (7.5YR 5/4) very cobbly loam; dark brown (7.5YR 3/4) moist; weak fine and medium subangular blocky structure; slightly hard, very friable; slightly sticky and slightly plastic; common very fine and few fine and medium roots; common very fine and few fine tubular pores; many thick calcium carbonate coats and pendants on the undersides and sides of rock fragments; 20 percent gravel, 25 percent cobble; strongly effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

Bk2—6 to 9 inches; brown (7.5YR 5/4) very cobbly loam; dark brown (7.5YR 3/4) moist; weak fine and medium subangular blocky structure; slightly hard, very friable; slightly sticky and slightly plastic; common very fine and few fine through coarse roots; common very fine and few fine tubular pores; many thick calcium carbonate coats and pendants on the undersides and sides of rock fragments; 20 percent gravel, 25 percent cobble; strongly effervescent; moderately alkaline (pH 8.4); abrupt wavy boundary.

Bkm—9 to 15 inches; indurated petrocalcic horizon.

R—15 inches; sandstone bedrock.

Range in Characteristics

Clay content (control section): 14 to 18 percent
Rock fragment content (control section): 35 to 70 percent, mostly gravel

Depth to bedrock: 15 to 25 inches

Depth to petrocalcic horizon: 7 to 20 inches

A horizon

Hue: 5YR, 7.5YR

Value: 4 through 6 dry, 3 through 6 moist

Chroma: 4 through 6, dry or moist

Bk horizon

Value: 4 through 6 dry, 3 or 4 moist

Chroma: 3 through 6, dry or moist

Calcium carbonate equivalent: 15 to 30 percent

Some pedons have a Bw horizon above the Bk horizon.

Puertecito family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Ustic Haplargids

Geomorphic position: summits and sideslopes of low hills and ridges

Parent material: residuum weathered from calcareous

sandstone and/or residuum weathered from cherty limestone

Slope: 2 to 8 percent

Surface fragments: about 70 percent gravel, about 5 percent cobbles

Depth to restrictive feature: 10 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.40 in/hr (moderately slow)

Available water capacity total inches: 1.7

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: High

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Shallow Loamy 10-14" p.z.

Ecosystem site number: 035XC319AZ

Present native vegetation: Wyoming big sagebrush, blue grama, galleta, ephedra, bottlebrush squirreltail

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Kanab Plateau, Kanab Point; 36 degrees, 24 minutes, 35 seconds north latitude; 112 degrees, 39 minutes, 56 seconds west longitude.

A—0 to 1 inch; yellowish red (5YR 4/6) very gravelly fine sandy loam; dark yellowish red (5YR 3/4) moist; strong thick platy structure; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; many very fine through coarse vesicular pores; 55 percent gravel; slightly effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

Bt—1 to 4 inches; dusky red (2.5YR 3/4) very gravelly sandy clay loam; dark dusky red (2.5YR 2.5/4) moist; weak fine subangular blocky structure parting to strong very fine granular; soft, very friable, very sticky and moderately plastic; few very fine roots; many very fine and fine interstitial pores; 35 percent gravel; strongly effervescent; moderately alkaline (pH 8.2); abrupt wavy boundary.

Btk1—4 to 16 inches; dusky red (2.5YR 3/3) very gravelly sandy clay loam; dark dusky red (2.5YR 2.5/3) moist; weak coarse subangular blocky structure parting to strong fine and medium granular; hard, firm, very sticky and moderately plastic; few fine and medium roots; few fine tubular pores; common distinct clay films lining pores; common fine and medium soft

masses of calcium carbonate; 40 percent gravel; strongly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Btk2—16 to 20 inches; dusky red (2.5YR 3/3) very gravelly clay loam; dark dusky red (2.5YR 2.5/3) moist; strong fine angular blocky structure; hard, firm, very sticky and moderately plastic; common fine and medium roots; few fine tubular pores; common distinct clay films lining pores; few fine soft masses of calcium carbonate; 55 percent gravel; strongly effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

R—20 inches; sandstone bedrock.

Range in Characteristics

Clay content (control section): 18 to 35 percent
Rock fragment content (control section): 35 to 60 percent

Depth to argillic horizon: 2 to 7 inches

Depth to carbonates: 4 to 9 inches

Depth to bedrock: 10 to 20 inches

A horizon

Hue: 5YR, 7.5YR, 10YR

Value: 4 through 6 dry, 3 or 4 moist

Chroma: 3 through 6, dry or moist

Calcium carbonate equivalent: 0 to 5 percent

Btk horizons

Hue: 2.5YR, 5YR, 7.5YR, 10YR

Value: 3 through 5, dry or moist

Chroma: 3 through 6, dry or moist

Calcium carbonate equivalent: 5 to 15 percent

Some Btk horizons are weakly cemented with calcium carbonate but do not meet the thickness requirement for a calcic horizon.

Mellenthin family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Ustic Haplocalcids

Geomorphic position: summits and sideslopes of low hills and ridges

Parent material: colluvium and/or residuum weathered from limestone

Slope: 2 to 25 percent

Surface fragments: about 5 percent stones, about 50 percent coarse gravel, about 10 percent cobbles

Depth to restrictive feature: 8 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 0.9

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Shallow Loamy 10-14" p.z.

Ecosystem site number: 035XC319AZ

Present native vegetation: Wyoming big sagebrush, blue grama, galleta, ephedra, bottlebrush squirreltail

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Kanab Plateau, SB Point; 36 degrees, 18 minutes, 17 seconds north latitude; 112 degrees, 49 minutes, 45 seconds west longitude.

A—0 to 1 inch; brown (7.5YR 5/4) extremely gravelly loam; brown (7.5YR 4/4) moist; weak fine and medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and few fine roots; many very fine and fine tubular pores; 65 percent gravel, 2 percent cobble; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bk1—1 to 5 inches; brown (7.5YR 5/4) very gravelly loam; brown (7.5YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine and common medium roots; many very fine and fine and few medium tubular pores; many moderately thick calcium carbonate coats and pendants on the undersides of rock fragments; 40 percent gravel, 2 percent cobble; violently effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

Bk2—5 to 11 inches; brown (7.5YR 5/4) extremely gravelly loam; brown (7.5YR 4/4) moist; weak fine and medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine through coarse roots; common fine and medium tubular pores; common fine soft masses of calcium carbonate; many moderately thick calcium carbonate coats and pendants on the undersides of rock fragments; 60 percent gravel, 5 percent cobble; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

R—11 inches; limestone conglomerate bedrock.

Range in Characteristics

Clay content (control section): 10 to 15 percent

Rock fragment content (control section): 35 to 65 percent

Depth to calcic horizon: 4 to 7 inches

Depth to bedrock: 8 to 20 inches

A horizon

Value: 4 through 6, dry or moist

Chroma: 4 through 6, dry or moist

Bk horizon

Hue: 7.5YR, 10 YR

Value: 5 through 8 dry, 4 through 8 moist

Chroma: 2 through 4, dry or moist

Some pedons have a Bw horizon above the Bk horizon.

Some calcic horizons are weakly to moderately cemented with calcium carbonate but do not meet the requirements for a petrocalcic horizon.

Some pedons have a discontinuous, 1-cm to 3-cm thick, fractured, non-root restrictive, weakly to strongly calcium carbonate cemented laminar pan overlying limestone or calcareous fine-grained sandstone bedrock.

31—Curhollow-Tenderfoot complex, 1 to 8 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,600 to 6,100 feet (1,402 to 1,859 meters)

Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)

Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)

Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)

Frost-free period: 145 to 175 days

Map Unit Composition

Curhollow and similar soils: 65 percent

Tenderfoot and similar soils: 30 percent

Minor components: 5 percent

- Deep soils in drainageways
- Soils that are less than 10 inches deep

Properties and Qualities

Curhollow soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic, shallow Calcic Petrocalcids

Geomorphic position: summits

Parent material: colluvium derived from limestone

Slope: 1 to 8 percent

Depth to restrictive feature: 16 to 25 inches to bedrock (lithic); 10 to 20 inches to petrocalcic

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 1.1

Shrink-swell potential: about 1.5 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Low

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Shallow Loamy 10-14" p.z.

Ecosystem site number: 035XC319AZ

Present native vegetation: Wyoming big sagebrush, blue grama, galleta, ephedra, bottlebrush squirreltail

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau, about 1,950 feet north and 2,300 feet west of the southeast corner of section 21, township 30 north, range 6 west, 35 degrees, 58 minutes, 4.3 seconds north latitude; 112 degrees, 55 minutes, 56.3 seconds west longitude.

A—0 to 2 inches; brown (10YR 5/3) extremely gravelly loam; brown (10YR 4/3) moist; weak thick platy structure; soft, very friable, nonsticky and nonplastic; many very fine roots; common very fine vesicular pores; 55 percent gravel, 10 percent cobble, noneffervescent; slightly alkaline (pH 7.4); clear smooth boundary.

Bk1— 2 to 9 inches; light brown (7.5YR 6/3) extremely gravelly loam; brown (7.5YR 4/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; many very fine soft calcium carbonate masses and thin coatings on rock fragments; 50 percent gravel, 10 percent cobble; strongly effervescent; slightly alkaline (pH 7.8); clear smooth boundary.

Bk2— 9 to 13 inches; light brown (7.5YR 6/3) extremely gravelly loam; brown (7.5YR 4/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; many very fine soft calcium carbonate masses and thin coatings on rock fragments; 50 percent gravel, 15

percent cobble; strongly effervescent; slightly alkaline (pH 7.8); abrupt smooth boundary.

Bkm—13 to 22 inches; indurated petrocalcic horizon; abrupt smooth boundary.

R—22 inches; limestone bedrock.

Range in Characteristics

Clay content (control section): 18 to 27 percent

Rock fragment content (control section): 35 to 75 percent

Reaction: slightly to moderately alkaline

Depth to bedrock: 16 to 25 inches

Bk horizon

Clay content: 20 to 30 percent

Calcium carbonate equivalent: 15 to 40 percent

Tenderfoot soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic, shallow Calcic Paleargids

Geomorphic position: summits

Parent material: alluvium derived from cherty limestone

Slope: 1 to 8 percent

Depth to restrictive feature: 16 to 40 inches to bedrock (lithic); 10 to 20 inches to petrocalcic

Drainage class: Well drained

Permeability: about 0.40 in/hr (moderately slow)

Available water capacity total inches: 1.6

Shrink-swell potential: about 4.5 LEP (moderate)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Low

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Shallow Loamy 10-14" p.z.

Ecosystem site number: 035XC319AZ

Present native vegetation: Wyoming big sagebrush, blue grama, galleta, ephedra, bottlebrush squirreltail

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau, about 1,600 feet north and 2,100 feet west of the southeast corner of section 9, township 32 north, range 5 west; 36 degrees, 10 minutes, 11 seconds north latitude; 112 degrees, 49 minutes, 34.8 seconds west longitude.

A—0 to 3 inches; reddish brown (5YR 5/4) very gravelly loam; reddish brown (5YR 4/4) moist; weak thick platy structure parting to moderate fine granular; soft, very friable, slightly sticky and slightly plastic;

many very fine roots; many very fine irregular and vesicular pores; 35 percent gravel; noneffervescent; neutral (pH 6.9); abrupt smooth boundary.

Bt—3 to 9 inches, yellowish red (5YR 4/6) sandy clay loam; reddish brown (5YR 4/4) moist; moderate coarse subangular blocky structure; hard, friable, sticky and plastic; many very fine roots; many very fine tubular pores; few faint clay films lining pores; 10 percent gravel; noneffervescent; neutral (pH 6.9); abrupt wavy boundary.

Bk—9 to 17 inches; reddish brown (5YR 4/4) extremely cobbly sandy clay loam; dark reddish brown (5YR 3/4) moist; moderate fine subangular blocky structure; slightly hard, friable, sticky and slightly plastic; common very fine and fine roots; few very fine tubular pores; few thin calcium carbonate coatings lining pores and on rock fragments; 40 percent gravel, 30 percent cobble, dominantly hardpan fragments; slightly effervescent; neutral (pH 7.0); abrupt wavy boundary.

Bkm—17 to 23 inches; indurated petrocalcic horizon.

R—23 inches, limestone bedrock.

Range in Characteristics

Rock fragments: 35 to 65 percent gravel and cobble. A gravelly to extremely gravelly surface lag layer is common.

Depth to petrocalcic horizon: dominantly 14 to 20 inches, but ranges from 10 to 20 inches

Depth to bedrock: 16 to 40 inches

Calcium carbonate equivalent: less than 30 percent above the hardpan

Organic matter: averages more than 1 percent in the surface horizon

A horizon

Hue: 5YR, 7.5YR

Value: 4 or 5 dry, 3 or 4 moist

Chroma: 4 or 5 dry, 3 or 4 moist

Bt horizon

Hue: 5YR, 7.5YR

Value: 4 or 5 dry, 3 or 4 moist

Chroma: 3, 4 or 6, dry or moist

Texture: clay loam, loam, sandy clay loam

Reaction: neutral or slightly alkaline

Bk horizon

Hue: 5YR, 7.5YR

Value: 4, 5 or 6 dry, 3 or 4 moist

Chroma: 4 dry, 3 or 4 moist

Texture: clay loam, loam, sandy clay loam, fine sandy loam

Reaction: neutral or slightly alkaline

32—Curob-Whirlo families complex, 15 to 30 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,500 to 5,000 feet (1,372 to 1,524 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 55 to 57 degrees F (13 to 14 degrees C)

Mean annual soil temperature: 57 to 59 degrees F (15 to 16 degrees C)

Frost-free period: 210 to 230 days

Map Unit Composition

Curob family and similar soils: 50 percent

Whirlo family and similar soils: 40 percent

Minor components: 10 percent

- Soils that have accumulation of calcium carbonate in the profile
- Soils that are deep or very deep to bedrock
- Soils that have gypsum present in the profile
- Skree slopes which are devoid of vegetation
- Soils that have an accumulation of clay in the profile

Properties and Qualities

Curob family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic, shallow Typic Petrocalcids

Geomorphic position: summits of fan terraces on colluvial side slopes of plateau escarpments and canyon sidewalls

Parent material: alluvium derived from limestone and sandstone and/or colluvium derived from limestone and sandstone

Slope: 15 to 30 percent

Surface fragments: about 25 percent gravel, about 25 percent cobble, about 5 percent stones

Depth to restrictive feature: 9 to 15 inches to petrocalcic

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 1.5

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Slopes, Shallow 6-10" p.z.

Ecosystem site number: 035XE517AZ

Present native vegetation: blackbrush, ephedra, banana yucca

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Tonto Platform; 680 feet southwest of Indian Garden; 36 degrees, 4 minutes, 55 seconds north latitude; 112 degrees, 7 minutes, 35 seconds west longitude.

A—0 to 2 inches; pale brown (10YR 6/3) very cobbly loam; dark yellowish brown (10YR 4/4) moist; moderate thin platy structure parting to weak very fine and fine subangular blocky; soft, very friable, slightly sticky and nonplastic; few very fine and fine roots, common fine vesicular and tubular pores; 30 percent gravel, 20 percent cobble; slightly effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bk1—2 to 8 inches; pale brown (10YR 6/3) very cobbly loam; dark yellowish brown (10YR 4/4) moist; moderate fine subangular blocky structure; soft, very friable, slightly sticky and nonplastic; few very fine and fine roots; common very fine and fine tubular pores; many thick calcium carbonate coats and pendants on the undersides and sides of rock fragments; 20 percent gravel, 30 percent cobble; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bk2—8 to 13 inches; very pale brown (10YR 7/3) very cobbly very fine sandy loam; yellowish brown (7.5YR 5/4) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and nonplastic; common very fine through medium and few coarse roots; common very fine and fine and few medium tubular pores; many thick calcium carbonate coats and pendants on the undersides and sides of rock fragments; 20 percent gravel, 30 percent cobble; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

Bkm—13 inches; indurated petrocalcic horizon.

Range in Characteristics

Depth to petrocalcic horizon: 9 to 15 inches

Percent clay: 10 to 15 percent in the particle size control section

Rock fragments: 35 to 70 percent in the particle size control section

Calcium carbonate equivalent: Fine earth fraction averages 15 to 40 percent

A horizon

Value: 5 through 7 dry, 3 or 4 moist

Chroma: 2 through 4

Bk horizons

Value: 5 or 6 dry

Whirlo family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Typic Haplocambids

Geomorphic position: side slopes and toeslopes of fan terraces on colluvial slopes of plateau escarpments and canyon sidewalls

Parent material: alluvium derived from calcareous sandstone and/or residuum weathered from calcareous sandstone

Slope: 15 to 30 percent

Surface fragments: about 50 percent gravel, about 10 percent cobble, about 5 percent stones

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 3.5

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: C

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Slopes 6-10" p.z.

Ecosystem site number: 035XE507AZ

Present native vegetation: black grama, desert needlegrass, blackbrush, blue threeawn, ephedra, Opuntia

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Tonto Platform; 1,876 feet southwest of Indian Garden; 36 degrees, 4 minutes, 53 seconds north latitude; 112 degrees, 7 minutes, 32 seconds west longitude.

A—0 to 3 inches; brown (7.5YR 5/4) extremely gravelly sandy loam; brown (7.5YR 4/4) moist; moderate thin platy structure; slightly hard, very friable, moderately sticky and slightly plastic; common very fine roots; common very fine and fine vesicular pores; 50 percent gravel, 15 percent cobble; slightly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bw1—3 to 8 inches; strong brown (7.5YR 4/6) very gravelly silt loam; brown (7.5YR 4/4) moist; moderate fine subangular blocky structure; slightly hard, very friable, moderately sticky and slightly plastic; many very fine and fine roots; many very fine and fine tubular pores; 45 percent gravel, 5 percent cobble; slightly

effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bw2—8 to 22 inches; strong brown (7.5YR 4/6) very gravelly sandy loam; brown (7.5YR 4/4) moist; strong medium subangular blocky structure; hard, friable, moderately sticky and moderately plastic; common very fine and fine roots; many very fine and fine and common medium tubular pores; 45 percent gravel; slightly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

C—22 to 60 inches; strong brown (7.5YR 4/6) very gravelly silt loam; brown (7.5YR 4/4) moist; massive; slightly hard, very friable, nonsticky and nonplastic; 40 percent gravel; slightly effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Control section: clay content is 5 to 15 percent in the particle size control section

Rock fragments: average 35 to 70 percent in the particle size control section, mainly gravel

A horizon

Value: 5 through 7 dry, 3 or 4 moist

Chroma: 2 through 6

Reaction: Neutral to moderately alkaline

Bw horizons

Value: 6 or 7 dry, 4 or 5 moist

Chroma: 2 or 3

33—Deama-Rock outcrop complex, 25 to 55 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,500 to 7,000 feet (1,372 to 2,134 meters)

Mean annual precipitation: 14 to 16 inches (356 to 406 millimeters)

Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)

Mean annual soil temperature: 50 to 54 degrees F (11 to 13 degrees C)

Frost-free period: 135 to 150 days

Map Unit Composition

Deama and similar soils: 70 percent

Rock outcrop: 20 percent

Minor components: 10 percent

• Soils in drainageways that are subject to occasional flooding

- Soils that are deeper than 20 inches
- Soils that have a lower amount of calcium carbonate

Properties and Qualities

Deama soils

Taxonomic classification: Loamy-skeletal, carbonatic, mesic Lithic Calciustolls

Geomorphic position: summits

Parent material: alluvium derived from limestone and/or colluvium derived from limestone and/or residuum weathered from limestone

Slope: 25 to 55 percent

Depth to restrictive feature: 7 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 1.6

Shrink-swell potential: about 1.5 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Limestone Slopes (PIED, JUOS) 13-17" p.z.

Ecosystem site number: 035XF613AZ

Present native vegetation: muttongrass, Artemisia, Stansbury cliffrose, Colorado pinyon, Utah juniper

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau, about 1,100 feet south and 2,000 feet west of the northeast corner of section 26, township 31 north, range 6 west; 36 degrees, 2 minutes, 47.6 seconds north latitude; 112 degrees, 53 minutes, 51.2 seconds west longitude.

A—0 to 1 inch; brown (10YR 5/3) extremely cobbly loam; dark brown (10YR 4/3) moist; weak fine granular structure; soft, very friable, nonsticky and slightly plastic; many very fine roots; many very fine vesicular and common fine tubular pores; 30 percent gravel, 35 percent cobble, 5 percent stones; violently effervescent; moderately alkaline (pH 8.0); clear smooth boundary.

Bk1—1 to 6 inches; dark brown (10YR 4/3) very cobbly loam; dark brown (10YR 3/3) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; 25 percent

gravel, 25 percent cobble, 5 percent stones; violently effervescent; moderately alkaline (pH 8.0); gradual smooth boundary.

Bk2—6 to 14 inches; brown (10YR 5/3) very cobbly loam; dark brown (10YR 3/3) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; common fine tubular pores; 30 percent gravel, 20 percent cobble, and 5 percent stone; violently effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

R—14 inches; limestone bedrock.

Range in Characteristics

Depth to bedrock: 7 to 20 inches

Reaction: Slightly to strongly alkaline

Rock fragments: 35 to 85 percent in the particle size control section

Clay content: 18 to 27 percent in the particle size control section

Calcium carbonate equivalent: 40 to 60 percent in the particle size control section

A horizon

Hue: 5YR to 10YR

Value: 3 through 6 dry, 2 through 4 moist

Chroma: 2 or 3, dry or moist

Bk horizon

Hue: 5YR to 10YR

Value: 4 through 8 dry, 3 through 7 moist

Chroma: 2 through 4, dry or moist

Rock outcrop

Escarments of limestone of the Kaibab Formation

34—Dera family, 15 to 55 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,500 to 5,000 feet (1,372 to 1,524 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 55 to 57 degrees F (13 to 14 degrees C)

Mean annual soil temperature: 57 to 59 degrees F (15 to 16 degrees C)

Frost-free period: 180 to 195 days

Map Unit Composition

Dera family and similar soils: 75 percent

Minor components: 25 percent

- Soils that have petrocalcic horizons
- Soils in drainageways that are occasionally flooded
- Soils that are shallow to bedrock
- Soils that have no accumulation of calcium carbonate in the profile
- Talus slopes devoid of vegetation

Properties and Qualities

Dera family soils

Taxonomic classification: Loamy-skeletal, carbonatic, mesic Typic Haplocalcids

Geomorphic position: summits and side slopes of fan terraces on colluvial slopes of plateau escarpments and canyons

Parent material: alluvium and/or colluvium derived from limestone and sandstone

Slope: 15 to 55 percent

Surface fragments: about 10 percent boulders, about 35 percent gravel, about 15 percent cobbles, about 15 percent stones

Drainage class: Well drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 2.4

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: B

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Slopes 6-10" p.z.

Ecosystem site number: 035XE507AZ

Present native vegetation: black grama, desert needlegrass, blackbrush, blue threeawn, ephedra, Opuntia

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Tonto Platform; 2,776 feet northeast of Indian Garden; 36 degrees, 4 minutes, 55 seconds north latitude; 112 degrees, 6 minutes, 41 seconds west longitude.

A—0 to 1 inch; pinkish gray (7.5YR 7/2) extremely bouldery silt loam; light brown (7.5YR 6/3) moist; moderate thin platy structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine vesicular pores; 35 percent gravel, 15 percent cobble, 10 percent stone, and 15 percent boulder; violently effervescent; strongly alkaline (pH 8.6); abrupt smooth boundary.

Bw—1 to 3 inches; light brown (7.5YR 6/4) extremely bouldery silt loam; brown (7.5YR 5/4) moist; moderate

fine and medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine roots; common very fine and few fine tubular pores; 35 percent gravel, 15 percent cobble, 10 percent stone, and 15 percent boulder; violently effervescent; strongly alkaline (pH 8.6); abrupt irregular boundary.

Bk1—3 to 24 inches; pinkish white (7.5YR 8/2) extremely cobbly loam; pinkish gray (7.5YR 7/2) moist; massive; hard, firm, slightly sticky and slightly plastic; common very fine and fine roots; few very fine and fine tubular pores; weakly cemented by calcium carbonate; 20 percent gravel, 35 percent cobble, 10 percent stone, and 10 percent boulder; violently effervescent; strongly alkaline (pH 8.6); abrupt irregular boundary.

Bk2—24 to 60 inches; pink (7.5YR 8/3) extremely cobbly loam; pinkish gray (7.5YR 7/2) moist; massive; very hard, very firm, slightly sticky and slightly plastic; common very fine and few fine roots; few very fine tubular pores; weakly to moderately cemented by calcium carbonate; 35 percent gravel, 25 percent cobble, 5 percent stone, and 10 percent boulder; violently effervescent; strongly alkaline (pH 8.6).

Range in Characteristics

Rock fragment content: 35 to 75 percent in the control section

Calcium carbonate equivalent: 40 to 50 percent

Clay content: 10 to 20 percent in the control section

A horizon

Hue: 10YR, 7.5YR

Value: 5 through 7 dry, 4 through 6 moist

Chroma: 2 through 4

BK horizon

Hue: 10YR, 7.5YR

Value: 5 through 8 dry, 4 through 7 moist

Chroma: 2 through 4

35—Disterheff-Albers association, 1 to 3 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,900 to 6,100 feet (1,798 to 1,860 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)

Mean annual soil temperature: 50 to 54 degrees F (11 to 13 degrees C)

Frost-free period: 135 to 150 days

Map Unit Composition

Disterheff and similar soils: 60 percent

Albers and similar soils: 30 percent

Minor components: 10 percent

- Kellypoint soils
- Albers silty clay loam, occasionally flooded
- Soils that have a gravelly or cobbly surface phase

Properties and Qualities

Disterheff soils

Taxonomic classification: Fine, smectitic, mesic Vertic Haplustalfs

Geomorphic position: summits and side slopes of low hills

Parent material: residuum weathered from basalt

Slope: 1 to 3 percent

Surface fragments: about 10 percent coarse gravel

Drainage class: Well drained

Permeability: about 0.01 in/hr (very slow)

Available water capacity total inches: 9.0

Shrink-swell potential: about 10.0 LEP (very high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Low

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Clay Loam Upland, Gravelly (PIED, JUOS) 13-17" p.z

Ecosystem site number: 035XF611AZ

Present native vegetation: muttongrass, Utah juniper, Wyoming big sagebrush, blue grama, Colorado pinyon

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Shivwits Plateau; 1.43 miles southwest of Spencer Tank; 36 degrees, 2 minutes, 16 seconds north latitude; 113 degrees, 27 minutes, 29 seconds west longitude.

A—0 to 2 inches; strong brown (7.5YR 4/6) loam; dark brown (7.5YR 3/4) moist; weak very fine prismatic structure; soft, very friable, moderately sticky and moderately plastic; few very fine and fine roots; many very fine irregular and tubular pores; slightly effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bt1—2 to 8 inches; brown (7.5YR 5/4) clay; dark brown (7.5YR 3/4) moist; strong fine and medium subangular

blocky structure parting to strong very fine angular blocky; hard, friable, very sticky and very plastic; common very fine and fine and few medium and coarse roots; common very fine through medium tubular pores; 5 percent chert gravel; few faint clay films lining pores; slightly effervescent; moderately alkaline (pH 8.0); clear wavy boundary.

Bt2—8 to 24 inches; reddish brown (5YR 5/4) clay; dark reddish brown (5YR 3/4) moist; strong medium prismatic structure parting to strong fine and medium angular blocky; very hard, firm, very sticky and very plastic; few very fine through coarse roots; common fine and medium and few coarse tubular pores; common faint clay films on faces of peds and lining pores; strongly effervescent; moderately alkaline (pH 8.0); gradual wavy boundary.

Btk1—24 to 45 inches; reddish brown (5YR 5/4) clay; reddish brown (5YR 4/4) moist; moderate medium prismatic structure parting to moderate fine and medium angular blocky; many cracks between prisms which extend to within 24 inches of the surface; very hard, firm, very sticky and very plastic; few fine and medium roots; few fine and medium tubular pores; many faint and common distinct clay films on faces of peds; common medium soft masses of calcium carbonate; strongly effervescent; moderately alkaline (pH 8.0); gradual wavy boundary.

Btk2—45 to 60 inches; light reddish brown (5YR 6/4) clay; reddish brown (5YR 4/4) moist; massive; few cracks 1/4 inch wide; very hard, very firm, very sticky and very plastic; few fine roots; few fine tubular pores; 10 percent gravel; common faint clay films on faces of peds; common medium and few coarse soft masses of calcium carbonate; strongly effervescent; moderately alkaline (pH 8.0).

Range in Characteristics

Depth to calcic horizon: 17 to 30 inches

A horizon

Hue: 7.5YR, 10YR

Value: 3 or 4, dry or moist

Chroma: 4 through 6, dry or moist

Bt horizon

Hue: 5YR, 7.5YR

Value: 5 or 6 dry, 3 or 4 moist

Chroma: 3 or 4, dry or moist

Clay content: 40 to 50 percent

Rock fragments: 0 to 5 percent

Btk horizon

Hue: 5YR, 7.5YR

Value: 4 through 8 dry, 3 through 6 moist
 Chroma: 3 or 4, dry or moist
 Calcium carbonate equivalent: 15 to 40 percent
 Clay content: 40 to 50 percent
 Rock fragments: 15 to 25 percent

Albers soils

Taxonomic classification: Fine, smectitic, mesic Aridic Haplusterts

Geomorphic position: Concavities and broad drainageways between hills

Parent material: alluvium derived from basalt

Slope: 1 to 3 percent

Drainage class: Well drained

Permeability: about 0.01 in/hr (very slow)

Available water capacity total inches: 9.6

Shrink-swell potential: about 12.0 LEP (very high)

Flooding hazard: Occasional ponding

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Negligible

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Loamy Upland 13-17" p.z.

Ecosystem site number: 035XF605AZ

Present native vegetation: Wyoming big sagebrush, blue grama, muttongrass, western wheatgrass, other evergreen trees

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Shivwits Plateau; 1.73 miles south of Ambush Water Pocket; 36 degrees, 2 minutes, 45 seconds north latitude; 113 degrees, 27 minutes, 38 seconds west longitude.

A1—0 to 2 inches; brown (7.5YR 5/3) silty clay loam; very dark brown (7.5YR 2.5/3) moist; moderate medium play structure; soft, very friable, slightly sticky and slightly plastic; common fine and medium and few coarse roots; many very fine irregular and tubular and common fine tubular pores; noneffervescent; neutral (pH 6.6); abrupt smooth boundary.

A2—2 to 5 inches; dark brown (7.5YR 3/3) silty clay loam; very dark brown (7.5YR 2.5/3) moist; weak medium subangular blocky structure parting to strong very fine granular; soft, very friable, very sticky and slightly plastic; many very fine and fine and few medium and coarse roots; many very fine irregular and tubular and common fine tubular pores; noneffervescent; neutral (pH 6.8); abrupt smooth boundary.

Btss1—5 to 14 inches; brown (7.5YR 4/3) silty clay;

very dark brown (7.5YR 2.5/3) moist; moderate medium prismatic structure parting to strong fine and medium angular; hard, friable, very sticky and very plastic; common very fine through coarse roots; common fine through coarse tubular pores; many intersecting slickensides; few faint clay films on faces of peds and lining pores; noneffervescent; neutral (pH 6.8); clear wavy boundary.

Btss2—14 to 26 inches; brown (7.5YR 4/3) silty clay; very dark brown (7.5YR 2.5/3) moist; weak medium prismatic structure parting to strong fine and medium angular blocky; very hard, very firm, very sticky and very plastic; few fine through coarse roots; few fine and medium tubular pores; common intersecting slickensides; common faint clay films on faces of peds and lining pores; noneffervescent; neutral (pH 6.8); gradual wavy boundary.

Btss3—26 to 41 inches; brown (7.5YR 5/3) silty clay; dark brown (7.5YR 3/3) moist; weak medium subangular blocky structure; hard, friable, very sticky and very plastic; few fine roots; few fine and medium tubular pores; common intersecting slickensides; common faint clay films on faces of peds and lining pores; noneffervescent; neutral (pH 6.8); gradual wavy boundary.

2Btb1—41 to 50 inches; reddish brown (5YR 5/4) clay; dark reddish brown (5YR 3/4) moist; strong medium prismatic structure parting to strong fine and medium angular blocky; very hard, very firm, very sticky and very plastic; few fine roots; few fine tubular pores; 5 percent gravel; common distinct clay films on faces of peds and lining pores; noneffervescent; neutral (pH 6.8); gradual wavy boundary.

2Btb2—50 to 60 inches; yellowish red (5YR 4/6) clay; dark reddish brown (5YR 3/4) moist; massive; very hard, very firm, very sticky and very plastic; few fine tubular pores; 5 percent gravel; common distinct and few patchy faint clay films on faces of peds and lining pores; noneffervescent; neutral (pH 7.2).

Range in Characteristics

Clay content: 40 to 60 percent in the particle size control section

Rock fragments: average less than 5 percent in the particle size control section

Cracking: Deep, wide cracks are open more than 210 days cumulative

A horizon

Hue: 10YR, 7.5YR

Value: 3 or 4 dry, 2, 2.5 or 3 moist

Chroma: 2 or 3, dry or moist

Btss horizons

Hue: 7.5YR, 10YR

Value: 3 through 5 dry, 2.5 through 4 moist

Chroma: 2 or 3, dry or moist

Calcium carbonate equivalent: 0 to 15 percent below 30 inches

Slickensides: common to many, becoming less common with depth

2Btb horizons (when present)

Hue: 5YR, 7.5YR

Value: 4 or 5 dry, 3 or 4 moist

Chroma: 4 through 6, dry or moist

Shrink-swell potential: about 9.0 LEP (very high)*Flooding hazard:* None*Seasonal water table minimum depth:* greater than 6 feet*Runoff class:* High*Hydrologic group:* D*Major Land Resource Area:* 35*Land Resource Unit:* 35-6*Ecological site name:* Limestone Upland (JUOS, PIED) 13-17" p.z.*Ecosystem site number:* 035XF619AZ*Present native vegetation:* Artemisia, Utah juniper, Colorado pinyon, Stansbury cliffrose, green Mormon tea*Land capability (nonirrigated):* 6c**36—Disterheff-Yumtheska complex, 2 to 6 percent slopes****Map Unit Setting***Landform:* plateau*Elevation:* 5,900 to 6,100 feet (1,798 to 1,860 meters)*Mean annual precipitation:* 14 to 18 inches (356 to 457 millimeters)*Mean annual air temperature:* 48 to 52 degrees F (9 to 11 degrees C)*Mean annual soil temperature:* 50 to 54 degrees F (11 to 13 degrees C)*Frost-free period:* 135 to 150 days**Map Unit Composition**

Disterheff and similar soils: 65 percent

Yumtheska and similar soils: 15 percent

Minor components: 20 percent

- Rock outcrop
- Bilburc soils
- Soils that have a cobbly surface phase
- Soils that have strongly cemented hardpans
- Soils that do not have calcium carbonate accumulations

Properties and Qualities**Disterheff soils***Taxonomic classification:* Fine, smectitic, mesic Vertic Haplustalfs*Geomorphic position:* summits*Parent material:* residuum weathered from cherty limestone*Slope:* 2 to 6 percent*Surface fragments:* about 40 percent coarse gravel*Drainage class:* Well drained*Permeability:* about 0.03 in/hr (very slow)*Available water capacity total inches:* 7.7**Taxonomic Unit Description**

Type Location: On the Shivwits Plateau; 3,473 feet southwest of Twin Point; 36 degrees, 1 minute 36 seconds north latitude; 113 degrees, 37 minutes, 46 seconds west longitude.

A1—0 to 2 inches; brown (7.5YR 5/4) very gravelly loam, dark brown (7.5YR 3/4) moist; weak thin platy structure parting to weak very fine granular; soft, very friable, nonsticky and nonplastic; few very fine roots; common very fine tubular pores; 50 percent gravel; noneffervescent; neutral (pH 7.2); abrupt smooth boundary.

A2—2 to 4 inches; brown (7.5YR 4/4) very gravelly loam, dark brown (7.5YR 3/4) moist; weak very fine granular structure; soft, very friable, moderately sticky and moderately plastic; few very fine roots; common very fine tubular pores; 40 percent gravel; noneffervescent; neutral (pH 7.0); abrupt smooth boundary.

Bt1—4 to 11 inches; brown (7.5YR 4/4) clay, dark brown (7.5YR 3/4) moist; strong medium subangular blocky structure; hard, firm, very sticky and very plastic; many very fine, common fine and medium and few coarse roots; many very fine, common fine and few medium tubular pores; common distinct clay films on faces of peds; 10 percent gravel; noneffervescent; neutral (pH 7.2); clear wavy boundary.

Bt2—11 to 20 inches; yellowish red (5YR 4/6) clay, reddish brown (5YR 4/4) moist; strong medium prismatic structure parting to strong fine angular blocky; very hard, very firm, very sticky and very plastic; common fine through coarse roots; common fine and medium tubular pores; many distinct clay films on faces of peds; 10 percent gravel; noneffervescent; slightly alkaline (pH 7.4); clear wavy boundary.

Bt3—20 to 26 inches; yellowish red (5YR 4/6) clay, yellowish red (5YR 4/6) moist; strong medium prismatic structure parting to strong medium angular blocky; very hard, very firm, very sticky and very plastic; few fine through coarse roots; few fine tubular pores; many distinct clay films on faces of peds; 10 percent gravel; slightly effervescent; moderately alkaline (pH 8.0); clear smooth boundary.

Btk—26 to 29 inches; light brown (5YR 6/4) clay loam, reddish yellow (5YR 6/6) moist; strong fine subangular blocky structure; hard, friable, very sticky and very plastic; few fine roots; few fine tubular pores; many faint clay films on faces of peds; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bk—29 to 60 inches; pinkish white (5YR 8/2) clay loam; light reddish brown (5YR 6/4) moist; massive; hard, friable, moderately sticky and moderately plastic; few fine roots; few fine irregular pores; few strongly calcium carbonate cemented masses; violently effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Depth to calcic horizon: 17 to 30 inches

Depth to bedrock: greater than 60 inches

Clay content: 40 to 50 percent in the particle size control section

Rock fragments: 5 to 50 percent gravel; averages less than 35 percent in the particle size control section

A horizon

Hue: 7.5YR, 10YR

Value: 3 through 5 dry, 3 or 4 moist

Chroma: 2 through 4, dry or moist

Bt horizons

Hue: 2.5YR, 5YR, 7.5YR

Value: 3 or 4, dry or moist

Chroma: 3 through 6, dry or moist

Reaction: neutral to moderately alkaline

Bk or Btk horizons

Hue: 2.5YR, 5YR, 7.5YR

Value: 4 through 8 dry, 5 or 6 moist

Chroma: 2 through 6 dry, 3 through 6 moist

Calcium carbonate equivalent: 15 to 40 percent

Properties and Qualities

Yumtheska soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Calciustolls

Geomorphic position: shoulders and sideslopes of hills and ridges

Parent material: colluvium and/or residuum weathered from limestone and sandstone

Slope: 2 to 6 percent

Surface fragments: about 50 percent coarse gravel

Depth to restrictive feature: 7 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 0.8

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Medium

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Limestone Upland (JUOS, PIED) 13-17" p.z.

Ecosystem site number: 035XF619AZ

Present native vegetation: Artemisia, Utah juniper, Colorado pinyon, Stansbury cliffrose, green Mormon tea

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Shivwits Plateau; 1.09 miles south of Twin Point; 36 degrees, 1 minute 4 seconds north latitude; 113 degrees, 37 minutes, 19 seconds west longitude.

A1—0 to 2 inches; brown (7.5YR 4/3) very gravelly loam, dark brown (7.5YR 3/3) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; few very fine tubular pores; 50 percent gravel composed mostly of indurated calcium carbonate fragments; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

A2—2 to 4 inches; brown (7.5YR 4/3) gravelly loam, dark brown (7.5YR 3/3) moist, moderate fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and moderately plastic; common very fine and fine roots; common very fine and fine tubular pores; 30 percent gravel composed mostly of indurated calcium carbonate fragments; violently effervescent; moderately alkaline (pH 8.2); abrupt wavy boundary.

Bk1—4 to 10 inches; brown (7.5YR 5/3) very gravelly silt loam, dark brown (7.5YR 3/3) moist; moderate fine

and medium subangular blocky structure; hard, very friable, moderately sticky and moderately plastic; many very fine through medium and common coarse roots; common very fine and fine tubular pores; 50 percent gravel composed mostly of indurated calcium carbonate fragments; many thick calcium carbonate coats and pendants on the undersides of rock fragments; violently effervescent; moderately alkaline (pH 8.2); abrupt wavy boundary.

R—10 inches; weathered limestone bedrock.

Range in Characteristics

Rock fragments: average more than 35 percent in the particle size control section

Clay content: averages 18 to 20 percent in the particle size control section

Depth to bedrock: 7 to 20 inches

A horizon

Hue: 7.5YR, 10YR

Value: 3 through 5, dry or moist

Chroma: 2 through 4 dry, 2 or 3 moist

Organic matter: averages 1 to 5 percent in the surface

Bk horizon(s)

Hue: 7.5YR, 10YR

Value: 3 through 7 dry, 3 through 5 moist

Chroma: 2 through 4, dry or moist

Calcium carbonate equivalent: 15 to 40 percent

37—Elledge family, 2 to 15 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 7,480 to 8,280 feet (2,280 to 2,523 meters)

Mean annual precipitation: 17 to 25 inches (432 to 635 millimeters)

Mean annual air temperature: 45 to 48 degrees F (7 to 9 degrees C)

Mean annual soil temperature: 47 to 50 degrees F (9 to 11 degrees C)

Frost-free period: 80 to 130 days

Map Unit Composition

Elledge family and similar soils: 90 percent

Minor components: 10 percent

- Soils that have no accumulation of clay in the profile
- Soils that have more than 35 percent by volume of rock fragments
- Rock outcrop
- Soils that are shallow to bedrock

- Soils in sinkholes that are very deep and frequently ponded
- Soils in drainageways that are occasionally flooded

Properties and Qualities

Elledge family soils

Taxonomic classification: Fine, mixed, superactive, mesic Typic Paleustalfs

Geomorphic position: summits and sideslopes of low hills and ridges

Parent material: residuum weathered from cherty limestone

Slope: 2 to 15 percent

Surface fragments: about 10 percent gravel

Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.01 in/hr (very slow)

Available water capacity total inches: 3.1

Shrink-swell potential: about 7.0 LEP (high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: High

Hydrologic group: C

Major Land Resource Area: 35

Land Resource Unit: 35-8

Ecological site name: Loamy Upland (PIPO) 17-25" p.z.

Ecosystem site number: 035XH808AZ

Present native vegetation: ponderosa pine, muttongrass, Ross sedge, big wildrye, creeping barberry, other coniferous trees, other deciduous trees

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Kaibab Plateau; 4,516 feet north of Walhalla Glades; 36 degrees, 10 minutes, 48 seconds north latitude; 111 degrees, 56 minutes, 38 seconds west longitude.

A—0 to 2 inches; grayish brown (10YR 5/2) sandy loam; very dark grayish brown (10YR 3/2) moist; moderate thin platy structure parting to strong very fine granular; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine tubular pores; 10 percent chert gravel and pedogenic hematite nodules; neutral (pH 7.2); abrupt smooth boundary.

AE—2 to 10 inches; pale brown (10YR 6/3) sandy loam; brown (10YR 4/3) moist; strong fine and medium

subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine and medium and few coarse roots; common fine and medium and few coarse tubular pores; 10 percent chert gravel and pedogenic hematite nodules; slightly alkaline (pH 7.4); clear wavy boundary.

Btss—10 to 20 inches; reddish brown (5YR 4/4) clay; reddish brown (5YR 4/4) moist; moderate medium prismatic structure parting to strong fine angular blocky; very hard, very firm, very sticky and very plastic; few medium roots; few fine tubular pores; common coarse organic matter stains along root channels; common slickensides; common distinct clay films on faces of pedis; slightly alkaline (pH 7.6); gradual wavy boundary.

Bt—20 to 26 inches; strong brown (7.5YR 5/6) clay; strong brown (7.5YR 4/6) moist; weak coarse prismatic structure parting to strong fine angular blocky; very hard; very firm, very sticky and very plastic; few medium roots; few fine tubular pores; common coarse organic matter stains along root channels; few faint clay films on faces of pedis; 10 percent sandstone gravel; slightly alkaline (pH 7.6).

R—26 inches; hard, slightly weathered sandstone bedrock.

Range in Characteristics

Rock fragments: average 0 to 35 percent in the control section

Clay content: averages 40 to 50 percent clay in the control section

Reaction: slightly acid to slightly alkaline

A horizon

Hue: 10YR

Value: 5 or 6 dry, 3 or 4 moist

Chroma: 2, 3 or 4, dry or moist

Bt horizon

Hue: 7.5YR, 5YR, 2.5YR

Value: 4 through 6 dry, 3 through 6 moist

Chroma: 3 through 6, dry or moist

38—Elledge family, 15 to 40 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 7,480 to 8,280 feet (2,280 to 2,523 meters)

Mean annual precipitation: 17 to 25 inches (432 to 635 millimeters)

Mean annual air temperature: 45 to 48 degrees F (7 to 9 degrees C)

Mean annual soil temperature: 47 to 50 degrees F (9 to 11 degrees C)

Frost-free period: 80 to 130 days

Map Unit Composition

Elledge family and similar soils: 90 percent

Minor components: 10 percent

- Soils that have no accumulation of clay in the profile
- Soils that have more than 35 percent by volume of rock fragments
- Rock outcrop
- Soils that are shallow to bedrock
- Soils in sinkholes that are very deep and frequently ponded
- Soils in drainageways that are occasionally flooded

Properties and Qualities

Elledge family soils

Taxonomic classification: Fine, mixed, superactive, mesic Typic Paleustalfs

Geomorphic position: shoulders and sideslopes of low hills and ridges

Parent material: residuum weathered from limestone and sandstone

Slope: 15 to 40 percent

Surface fragments: about 20 percent gravel

Depth to restrictive feature: 40 to 60 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.13 in/hr (slow)

Available water capacity total inches: 6.6

Shrink-swell potential: about 7.0 LEP (high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: C

Major Land Resource Area: 35

Land Resource Unit: 35-8

Ecological site name: Loamy Hills (PIPO) 17-25" p.z.

Ecosystem site number: 035XH805AZ

Present native vegetation: muttongrass, ponderosa pine, Gambel oak, Ross sedge, big wildrye

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Kaibab Plateau; 4,516 feet north of Walhalla Glades; 36 degrees, 10 minutes, 48 seconds north latitude; 111 degrees, 56 minutes, 38 seconds west longitude.

Oi—0 to 1 inch; partially decomposed pine litter.

A1—1 to 3 inches; grayish brown (10YR 5/2) gravelly loam; very dark grayish brown (10YR 3/2) moist; weak very thin platy structure parting to moderate very fine subangular blocky; soft, very friable, slightly sticky and nonplastic; many very fine and few fine roots; common very fine and few fine tubular pores; 20 percent gravel; noneffervescent; slightly acid (pH 6.4); abrupt wavy boundary.

A2—3 to 8 inches; brown (10YR 5/3) cobbly loam; dark yellowish brown (10YR 3/4) moist; weak very thin platy structure parting to moderate very fine subangular blocky; slightly hard, very friable, slightly sticky and nonplastic; many very fine and few fine and medium roots; common very fine and few fine tubular pores; 20 percent gravel, 15 percent cobble; noneffervescent; slightly acid (pH 6.3); clear wavy boundary.

Bt1—8 to 12 inches; brown (7.5YR 5/3) cobbly clay; dark brown (7.5YR 3/4) moist; weak thin platy structure parting to moderate very fine subangular blocky; slightly hard, friable, moderately sticky and moderately plastic; common very fine and few fine through coarse roots; common very fine and few fine tubular pores; few faint clay films lining pores and on faces of peds; 20 percent gravel, 10 percent cobble; noneffervescent; neutral (pH 6.6); clear wavy boundary.

Bt2—12 to 25 inches; brown (7.5YR 5/4) cobbly clay; brown (7.5YR 4/4) moist; moderate very fine subangular blocky structure; slightly hard, very friable, moderately sticky and moderately plastic; common very fine and few fine through coarse roots; common very fine and fine and few medium tubular pores; many faint clay films lining pores and common faint and few distinct clay films on faces of peds; 15 percent gravel, 15 percent cobble; noneffervescent; neutral (pH 6.6); clear wavy boundary.

Bt3—25 to 31 inches; reddish brown (5YR 5/4) stony clay; reddish brown (5YR 4/4) moist; weak fine prismatic structure parting to moderate fine subangular blocky; very hard, very firm, very sticky and very plastic; few very fine through coarse roots; common very fine and few fine tubular pores; many distinct clay films on the faces of peds; 15 percent gravel, 10 percent stone; noneffervescent; neutral (pH 6.8); clear wavy boundary.

Bt4—31 to 41 inches; reddish brown (5YR 5/4) stony clay; brown (7.5YR 4/4) moist; weak fine angular blocky structure; very hard, very firm, very sticky and very plastic; few very fine through coarse roots; few very fine and fine tubular pores; common distinct clay films on the faces of peds; 10 percent gravel, 10 percent stone; noneffervescent; neutral (pH 6.8); clear wavy boundary.

Bt5—41 to 53 inches; reddish yellow (7.5YR 6/6) very stony clay; reddish yellow (7.5YR 6/6) moist; weak fine and medium angular blocky structure; hard, very firm, moderately sticky and moderately plastic; few very fine through coarse roots; common very fine and few fine and medium tubular pores; common distinct clay films on the faces of peds; many faint clay films lining pores; 5 percent gravel, 50 percent stone; noneffervescent; neutral (pH 6.9); abrupt broken boundary.

R—53 inches; limestone bedrock.

Range in Characteristics

Rock fragments: average 5 to 35 percent in the control section

Clay content: averages 40 to 45 percent in the control section

Organic matter: 1 to 3 percent in the upper 7 inches

A horizon

Hue: 7.5YR, 10YR

Value: 4 or 5 dry; 2 through 4 moist

Chroma: 2 through 4, dry or moist

Bt horizon

Hue: 5YR, 7.5YR

Value: 3 through 6, dry or moist

Chroma: 3 through 6, dry or moist

39—Firo family-Sandia-Rock outcrop complex, 15 to 55 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,000 to 7,500 feet (1,524 to 2,286 meters)

Mean annual precipitation: 25 to 33 inches (635 to 838 millimeters)

Mean annual air temperature: 36 to 45 degrees F (2 to 7 degrees C)

Mean annual soil temperature: 38 to 47 degrees F (4 to 9 degrees C)

Frost-free period: 80 to 100 days

Map Unit Composition

Firo family and similar soils: 40 percent

Sandia and similar soils: 30 percent

Rock outcrop: 15 percent

Minor components: 15 percent

- Soils that have small amounts of organic matter in the profile

- Soils that have accumulation of calcium carbonate in the profile

- Soils that have accumulation of clay in the profile
- Talus slopes devoid of vegetation

Properties and Qualities

Firo family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, frigid Lithic Haplustolls
Geomorphic position: pockets and ledges on escarpments of plateaus
Parent material: colluvium derived from limestone and sandstone
Slope: 15 to 55 percent
Surface fragments: about 15 percent coarse gravel, about 5 percent stones, about 30 percent cobbles
Depth to restrictive feature: 14 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Permeability: about 4.00 in/hr (moderately rapid)
Available water capacity total inches: 1.3
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: very high
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-8
Ecological site name: Sedimentary Cliffs 17-25" p.z.
Ecosystem site number: 035XH809AZ
Present native vegetation: Gambel oak, New Mexico locust, other evergreen trees, Utah serviceberry, other deciduous trees
Land capability (nonirrigated): 5c

Taxonomic Unit Description

Type Location: On the Tonto Platform; 2,051 feet northeast of Transept Trail Campgrounds; 36 degrees, 12 minutes, 58 seconds north latitude; 112 degrees, 3 minutes, 15 seconds west longitude.

A1—0 to 2 inches; brown (10YR 4/3) very cobbly sandy loam; very dark brown (10YR 2/2) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and common medium roots; many very fine and fine tubular pores; 10 percent gravel, 35 percent cobble, and 10 percent stone; slightly effervescent; slightly alkaline (pH 7.8); abrupt smooth boundary.

A2—2 to 6 inches; brown (10YR 4/3) very cobbly sandy loam; very dark brown (10YR 2/2) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine, common medium and few coarse roots; many very fine

and fine and few medium tubular pores; 5 percent gravel, 30 percent cobble, and 10 percent stone; slightly effervescent; slightly alkaline (pH 7.8); clear smooth boundary.

A3—6 to 14 inches; brown (10YR 5/3) extremely stony sandy loam; dark brown (10YR 3/3) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine through coarse roots; common fine tubular pores; 5 percent gravel, 20 percent cobble, 40 percent stone; slightly effervescent; slightly alkaline (pH 7.8); abrupt irregular boundary.

R—14 inches; limestone bedrock.

Range in Characteristics

Depth to bedrock: 14 to 20 inches
 Rock fragments in the control section: 35 to 85 percent
 Clay content in the control section: averages 8 to 15 percent
 Organic matter: 2 to 5 percent

A horizon

Hue: 7.5YR, 10YR
 Value: 3 through 5 dry and 2 or 3 moist
 Chroma: 2 or 3, dry or moist

A C horizon is present in some pedons.

Sandia soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, frigid Udic Haplustolls
Geomorphic position: colluvial toeslopes and chutes on escarpments of plateaus
Parent material: colluvium derived from limestone, sandstone, and shale
Slope: 15 to 55 percent
Surface fragments: about 15 percent coarse gravel, about 5 percent stones, about 30 percent cobbles
Depth to restrictive feature: 40 to 60 inches to bedrock (lithic)
Drainage class: Well drained
Permeability: about 4.00 in/hr (moderately rapid)
Available water capacity total inches: 5.0 inches
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: very high
Hydrologic group: C
Major Land Resource Area: 35
Land Resource Unit: 35-9
Ecological site name: Sedimentary Cliffs 25-33" p.z.
Ecosystem site number: 035XI901AZ
Present native vegetation: Douglas-fir, Gambel oak, New Mexico locust, other evergreen trees, white fir, Symphoricarpos, Utah serviceberry

Land capability (nonirrigated): 5c

Taxonomic Unit Description

Type Location: On the Tonto Platform; 2,433 feet east of the Transept Trail Campgrounds; 36 degrees, 12 minutes, 58 seconds north latitude; 112 degrees, 3 minutes, 10 seconds west longitude.

A1—0 to 2 inches; brown (10YR 4/3) very stony loam; very dark brown (10YR 2/2) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and common medium roots; common very fine and fine tubular pores; 10 percent gravel, 20 percent cobble, and 25 percent stone; noneffervescent; slightly alkaline (pH 7.4); abrupt smooth boundary.

A2—2 to 6 inches; brown (10YR 4/3) extremely stony loam; very dark brown (10YR 2/2) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and common medium and coarse roots; common very fine and fine tubular pores; 15 percent gravel, 25 percent cobble, and 25 percent stone; noneffervescent; slightly alkaline (pH 7.4); clear smooth boundary.

Bw—6 to 12 inches; brown (10YR 5/3) very cobbly sandy loam; dark brown (10YR 3/3) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine through coarse roots; common fine and few medium tubular pores; 10 percent gravel, 25 percent cobble, and 10 percent stone; slightly effervescent; slightly alkaline (pH 7.8); clear smooth boundary.

2C1—12 to 30 inches; light yellowish brown (10YR 6/4) very cobbly sandy loam; yellowish brown (10YR 5/4) moist; massive; soft, very friable, nonsticky and nonplastic; common fine through coarse roots, common fine and few medium tubular pores; 10 percent gravel, 25 percent cobble, and 15 percent stone; strongly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

2C2—30 to 50 inches; light yellowish brown (10YR 6/4) very cobbly sandy loam; yellowish brown (10YR 5/4) moist; soft, very friable, nonsticky and nonplastic; few medium and coarse roots; few medium tubular pores; 15 percent gravel, 30 percent cobble, and 10 percent stone; strongly effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

2R—50 inches; limestone bedrock.

Range in Characteristics

This is a taxadjunct to the series. The series is Typic Ustic and this is Udic Ustic.

Depth to bedrock ranges from 40 to 60 inches
Rock fragments: 35 to 85 percent
Clay content: 8 to 15 percent

A horizon

Hue: 10YR,7.5YR
Value: 4 or 5 dry and 2 or 3 moist
Chroma: 1 or 2, dry or moist

Rock outcrop

Ledges and outcrops

40—Fluvaquents-Psamments complex, 2 to 6 percent slopes

Map Unit Setting

Landform: plateau
Elevation: 4,500 to 6,000 feet (1,372 to 1,829 meters)
Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)
Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)
Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)
Frost-free period: 145 to 160 days

Map Unit Composition

Fluvaquents and similar soils: 80 percent
Psamments and similar soils: 20 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Fluvaquents soils

Taxonomic classification: Fluvaquents
Geomorphic position: flood plains of riparian areas in side canyons with perennially flowing water
Parent material: alluvium derived from mixed sources
Slope: 2 to 6 percent
Depth to restrictive feature: 10 to 60 inches to bedrock (lithic)
Flooding hazard: Frequent
Seasonal water table minimum depth: about 20 inches
Major Land Resource Area: 35
Land Resource Unit: 35-3
Ecological site name: Canyon Springs 10-14" p.z.
Ecosystem site number: 035XC356AZ
Present native vegetation: common reed, coyote

willow, scouringrush horsetail, Nebraska sedge,
Baltic rush, broadleaf cattail, seepwillow baccharis
Land capability (nonirrigated): 6w

Taxonomic Unit Description

Type Location: On the Tonto Platform; 1,596 feet southwest of Indian Garden; 36 degrees, 4 minutes, 50 seconds north latitude; 112 degrees, 7 minutes, 30 seconds west longitude.

C—0 to 60 inches; strong brown (7.5YR 5/6) stratified sand to silty clay, strong brown (7.5YR 4/6) moist; single grain; loose, slightly sticky and slightly plastic; many very fine and few fine roots; many very fine irregular pores; strongly effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

The soils in these landscape positions are extremely variable with respect to depth, texture, rock fragment content and color. Because of the extreme variability, the soils here are described to the suborder only.

Psamments soils

Taxonomic classification: Psamments
Geomorphic position: sand bars in drainageways of side canyons
Parent material: alluvium derived from mixed sources
Slope: 2 to 6 percent
Depth to restrictive feature: 10 to 60 inches to bedrock (lithic)
Flooding hazard: Frequent
Seasonal water table minimum depth: greater than 6 feet
Major Land Resource Area: 35
Land Resource Unit: 35-3
Ecological site name: Sandy Bottom, Subirrigated 10-14" p.z.
Ecosystem site number: 035XC358AZ
Present native vegetation: coyote willow, China tamarisk, Fremont cottonwood, boxelder, other deciduous trees
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Tonto Platform; 1,690 feet west of Indian Garden; 36 degrees, 4 minutes, 48 seconds north latitude; 112 degrees, 7 minutes, 32 seconds west longitude.

C—0 to 60 inches; pink (7.5YR 7/3) sand, brown (10YR 5/3) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine

and fine roots; few fine and medium tubular pores; slightly effervescent; moderately alkaline (pH 8.2).

Range in Characteristics

The soils in these landscape positions are extremely variable with respect to depth, texture, rock fragment content and color. Because of the extreme variability, the soils here are described to the suborder only.

41—Fluvaquents-Psamments complex, warm, 2 to 6 percent slopes

Map Unit Setting

Landform: plateau
Elevation: 2,500 to 4,500 feet (762 to 1,372 meters)
Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)
Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)
Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)
Frost-free period: 200 to 280 days

Map Unit Composition

Fluvaquents and similar soils: 80 percent
Psamments and similar soils: 20 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Fluvaquents soils

Taxonomic classification: Fluvaquents
Geomorphic position: flood plains in riparian areas in side canyons with perennially flowing water
Parent material: alluvium derived from mixed sources
Slope: 2 to 6 percent
Depth to restrictive feature: 10 to 60 inches to bedrock (lithic)
Seasonal water table minimum depth: about 0 inches
Major Land Resource Area: 35
Land Resource Unit: 35-5
Ecological site name: Canyon Springs 6-10" p.z.
Ecosystem site number: 035XE506AZ
Present native vegetation: common reed, coyote willow, Ferris horsetail, Goodding willow, seepwillow baccharis, broadleaf cattail, water sedge

Land capability (nonirrigated): 7w

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 941 feet south of Pipe Creek; 36 degrees, 5 minutes, 49 seconds north latitude; 112 degrees, 6 minutes, 37 seconds west longitude.

C—0 to 60 inches; strong brown (7.5YR 5/6) stratified sand to silty clay, strong brown (7.5YR 4/6) moist; single grain; loose, slightly sticky and slightly plastic; many very fine and few fine roots; many very fine irregular pores; strongly effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

The soils in these landscape positions are extremely variable with respect to depth, texture, rock fragment content and color. Because of the extreme variability, the soils here are described to the suborder only.

Psamments soils

Taxonomic classification: Psamments

Geomorphic position: sand bars in drainageways in side canyons

Parent material: alluvium derived from mixed sources

Slope: 2 to 6 percent

Depth to restrictive feature: 10 to 60 inches to bedrock (lithic)

Flooding hazard: Frequent

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Sandy Bottom, Subirrigated 6-10" p.z.

Ecosystem site number: 035XE512AZ

Present native vegetation: China tamarisk, seepwillow baccharis, arrowweed, desert broom baccharis, other deciduous trees, catclaw acacia, honey mesquite

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 655 feet northeast of Pipe Creek; 36 degrees, 6 minutes, 4 seconds north latitude; 112 degrees, 6 minutes, 37 seconds west longitude.

C—0 to 60 inches; pink (7.5YR 7/3) sand, brown (10YR 5/3) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; few fine and medium tubular pores; slightly effervescent; moderately alkaline (pH 8.2).

Range in Characteristics

The soils in these landscape positions are extremely variable with respect to depth, texture, rock fragment content and color. Because of the extreme variability, the soils here are described to the suborder only.

42—Garr-Zibate families complex, 2 to 15 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,500 to 4,500 feet (1,067 to 1,372 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 200 to 240 days

Map Unit Composition

Garr family and similar soils: 50 percent

Zibate family and similar soils: 35 percent

Minor components: 15 percent

- Soils that have accumulation of calcium carbonate in the profile
- Soils that are deep or very deep to bedrock

Properties and Qualities

Garr family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, thermic Lithic Haplocambids

Geomorphic position: summits and side slopes of nearly flat to steeply sloping pediments

Parent material: residuum weathered from shale

Slope: 2 to 15 percent

Surface fragments: about 70 percent channers

Depth to restrictive feature: 12 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.3 in/hr (moderate)

Available water capacity total inches: 1.2

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: High

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Upland, Shallow 6-10" p.z.

Ecosystem site number: 035XE519AZ

Present native vegetation: blackbrush, ephedra,
Opuntia, banana yucca

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Tonto Platform; 1,070 feet southwest of Plateau Point; 36 degrees, 5 minutes, 18 seconds north latitude; 112 degrees, 7 minutes, 37 seconds west longitude.

A—0 to 1 inch; yellowish brown (10YR 5/4) extremely channery loam; brown (10YR 4/3) moist; moderate medium platy structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine irregular, few fine interstitial and few fine tubular pores; 75 percent channers; very slightly effervescent; slightly alkaline (pH 7.8); abrupt smooth boundary.

Bw1—1 to 2 inches; brown (7.5YR 5/4) channery clay loam; brown (7.5YR 4/4) moist; weak medium platy structure parting to strong very fine and fine granular; slightly hard, very friable, moderately sticky and moderately plastic; few very fine roots; many very fine irregular pores; 20 percent channers; slightly effervescent; slightly alkaline (pH 7.8), abrupt smooth boundary.

Bw2—2 to 6 inches; brown (7.5YR 5/4) very channery loam; brown (7.5YR 4/4) moist; weak fine subangular blocky structure parting to moderate fine granular; slightly hard, very friable, moderately sticky and moderately plastic; common very fine and few fine roots; common very fine irregular, few very fine tubular and common very fine interstitial pores; 50 percent channers; strongly effervescent; slightly alkaline (pH 7.8); clear smooth boundary.

Bw3—6 to 17 inches; dark reddish brown (5YR 3/2) extremely channery loam; dark reddish brown (5YR 2.5/2) moist; weak thin platy structure parting to moderate fine subangular blocky; hard, friable, sticky and moderately plastic; few very fine and very few fine roots; many very fine irregular and common very fine and few fine tubular pores; 70 percent channers; slightly effervescent; slightly alkaline (pH 7.8); abrupt smooth boundary.

R—17 inches; highly fractured Bright Angel Shale occurring in horizontal plates 5 to 12 millimeters thick with vertical fractures spaced 75 to 125 millimeters apart. Roots penetrate vertical fractures at intervals of less than 125 millimeters.

Range in Characteristics

Depth to bedrock: 12 to 20 inches

Reaction: slightly or moderately alkaline

Clay content: averages 22 to 32 percent in the particle size control section

Effervescence: Typically slight or strong in the subsoil.

Can range from noneffervescent to violent

Organic matter: less than 1 percent

A horizon

Hue: 7.5YR, 10YR

Value: 5 or 6 dry, 4 or 5 moist

Chroma: 3, 4 or 5, dry or moist

B horizons

Hue: 5YR, 7.5YR, 10YR

Value: 5 or 6 dry, 4 or 5 moist

Chroma: 4 or 5, dry or moist

Effervescence: slight or strong

Zibate family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, thermic Lithic Haplargids

Geomorphic position: summits and side slopes of nearly flat to steeply sloping pediments

Parent material: residuum weathered from calcareous sandstone

Slope: 2 to 15 percent

Surface fragments: about 40 percent gravel, about 5 percent cobbles

Depth to restrictive feature: 6 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.40 in/hr (moderately slow)

Available water capacity total inches: 0.8

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: High

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Upland, Shallow 6-10" p.z.

Ecosystem site number: 035XE519AZ

Present native vegetation: blackbrush, ephedra,
Opuntia, banana yucca

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Tonto Platform; 3,194 feet northeast of Garden Creek; 36 degrees, 5 minutes, 15 seconds north latitude; 112 degrees, 6 minutes, 9 seconds west longitude.

A—0 to 2 inches; brown (7.5YR 4/4) very gravelly loam; dark brown (7.5YR 3/4) moist; weak medium

subangular blocky structure parting to moderate very fine subangular blocky; soft, very friable, moderately sticky and moderately plastic; few very fine roots; many very fine irregular and tubular pores; 35 percent gravel and 5 percent cobble; slightly effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bt—2 to 8 inches; yellowish red (5YR 4/6) very gravelly clay loam; yellowish red (5YR 4/6) moist; moderate fine subangular blocky structure; slightly hard, friable, very sticky and very plastic; common very fine through medium roots; common fine and medium tubular pores; few faint clay films lining pores; common thin calcium carbonate coats and pendants on rock fragments; 40 percent gravel, 5 percent cobble; slightly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Btk—8 to 10 inches; red (2.5YR 4/6) extremely gravelly silty clay loam; dark red (5YR 4/6) moist; strong fine subangular blocky structure; slightly hard, friable, moderately sticky and moderately plastic; common medium and few coarse roots; common fine and few medium tubular pores; common distinct clay films on faces of peds and lining pores; common medium soft masses of calcium carbonate; many moderately thick calcium carbonate coats and pendants on rock fragments; 60 percent gravel, 5 percent cobble; strongly effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

R—10 inches; Tapeats sandstone bedrock.

Range in Characteristics

Depth to bedrock: 6 to 20 inches
Effervescence: noneffervescent to strongly effervescent

A horizon

Hue: 10YR, 7.5YR
Value: 3 through 6 dry, 3 through 5 moist
Chroma: 3 or 4, dry or moist

Bt horizon

Hue: 2.5YR, 5YR, 10YR, 7.5YR
Value: 3 through 5, dry or moist
Chroma: 3 through 6, dry or moist
Clay content: 18 to 35 percent
Rock fragments: 35 to 85 percent
Reaction: Slightly alkaline or moderately alkaline

43—Gypill fine sandy loam, 15 to 40 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 1,800 to 2,300 feet (548 to 701 meters)

Mean annual precipitation: 6 to 9 inches (152 to 229 millimeters)

Mean annual air temperature: 64 to 70 degrees F (18 to 21 degrees C)

Mean annual soil temperature: 66 to 72 degrees F (20 to 23 degrees C)

Frost-free period: 230 to 280 days

Map Unit Composition

Gypill and similar soils: 80 percent

Minor components: 20 percent

- Soils on foot slopes that are moderately deep to lacustrine sediments
- Arizo occasionally flooded
- Soils that have a gravelly and cobbly surface phase
- Gypill loam, 15 to 40 percent slopes

Properties and Qualities

Gypill soils

Taxonomic classification: Loamy, gypsic, thermic, shallow Typic Torriorthents

Geomorphic position: summits and side slopes of hills and ridges

Parent material: residuum weathered from sandstone and siltstone

Slope: 15 to 40 percent

Depth to restrictive feature: 4 to 17 inches to bedrock (paralithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 0.8

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: C

Major Land Resource Area: 30

Land Resource Unit: 30-2

Ecological site name: Gypsum Hills, Alkaline 6-9" p.z.

Ecosystem site number: 030XB222AZ

Present native vegetation: shadscale saltbush, Nevada Mormon tea, Torrey Mormon tea, creosotebush, desert trumpet buckwheat

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 1.87 miles south of Gyp Hills; 36 degrees, 16 minutes, 40 seconds north latitude; 113 degrees, 54 minutes, 45 seconds west longitude.

Ay—0 to 1 inch; light yellowish brown (10YR 6/4) fine sandy loam, strong brown (7.5YR 4/6) moist; moderate thin platy structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; many very fine irregular pores; 8 percent crystalline gypsum; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Cy—1 to 7 inches; very pale brown (10YR 7/4) sandy loam, yellowish brown (10YR 5/6) moist; weak thin platy structure; soft, very friable, nonsticky and nonplastic; few very fine roots; few very fine vesicular and irregular pores; 85 percent crystalline gypsum; few hard bodies of gypsum (no color difference from rest of matrix); common soft bodies of white (10YR 8/2) gypsum; strongly effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Cr—7 to 60 inches; semi-consolidated lacustrine sediments.

Range in Characteristics

Depth to paralithic contact: 4 to 17 inches
Rock fragments: average less than 15 percent gravel in the particle size control section

A horizon

Hue: 5YR, 7.5YR, 10YR
Value: 5 through 7 dry, 4 through 6 moist
Chroma: 4 through 6, dry or moist
Gypsum: 1 to 20 percent
Reaction: slightly alkaline to moderately alkaline
Calcium carbonate equivalent: 5 to 25 percent

Cy horizon

Hue: 5YR, 7.5YR, 10YR, 2.5Y, 5Y
Value: 5 through 8 dry, 4 through 8 moist
Chroma: 2 through 6, dry or moist
Gypsum: 30 to 90 percent
Reaction: slightly alkaline to moderately alkaline
Calcium carbonate equivalent: 5 to 35 percent
Rock fragments: 0 to 15 percent

Cr horizon

Variegated, rippable, gypsiferous lacustrine sediment

interbedded with thin to very thick (1/2 inch to 10 feet) layers of gypsum.

44—Gypill-Meadview complex, 2 to 15 percent slopes

Map Unit Setting

Landform: hill

Elevation: 1,500 to 2,000 feet (457 to 610 meters)

Mean annual precipitation: 6 to 9 inches (152 to 229 millimeters)

Mean annual air temperature: 64 to 70 degrees F (18 to 21 degrees C)

Mean annual soil temperature: 66 to 72 degrees F (20 to 23 degrees C)

Frost-free period: 230 to 280 days

Map Unit Composition

Gypill and similar soils: 60 percent

Meadview and similar soils: 25 percent

Minor components: 15 percent

- Orrubo very gravelly loam, 15 to 30 percent slopes
- Arizo occasionally flooded
- Soils on steeper slopes

Properties and Qualities

Gypill soils

Taxonomic classification: Loamy-skeletal, gypsic, thermic Typic Torriorthents

Geomorphic position: summits and sideslopes of hills and ridges

Parent material: residuum weathered from gypsum

Slope: 2 to 15 percent

Depth to restrictive feature: 24 to 34 inches to bedrock (paralithic)

Drainage class: Somewhat excessively drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 1.7

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Medium

Hydrologic group: C

Major Land Resource Area: 30

Land Resource Unit: 30-2

Ecological site name: Gypsum Upland, Alkaline 6-9" p.z.

Ecosystem site number: 030XB213AZ

Present native vegetation: Nevada Mormon tea, shadscale saltbush, white ratany, Fremont indigobush, desert trumpet buckwheat

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 36 degrees, 17 minutes, 0 seconds north latitude; 113 degrees, 55 minutes, 30 seconds west longitude.

C—0 to 1 inch; very pale brown (10YR 8/3) very fine sandy loam, yellowish brown (10YR 5/4) moist; single grain; loose, nonsticky and nonplastic; few very fine roots; common very fine irregular pores; 7 percent sand and gravel-sized gypsum crystals; strongly effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Cy1—1 to 5 inches; very pale brown (10YR 8/2) very gravelly sand, gray (10YR 6/1) moist; single grain; loose, nonsticky and nonplastic; many very fine and few fine irregular pores; few very fine and fine roots; 50 percent gravel-sized gypsum crystals, 30 percent sand-sized gypsum crystals; slightly effervescent; slightly alkaline (pH 7.8); gradual smooth boundary.

Cy2—5 to 20 inches; yellow (10YR 8/6) channery sandy loam, yellowish brown (10YR 5/8) moist; common loam bodies which are yellowish brown (10YR 5/4) dry and dark yellowish brown (10YR 4/6) moist; single grain; loose, nonsticky and nonplastic; common very fine irregular and few fine tubular pores; few very fine through medium roots; 30 percent channer-sized gypsum crystals; 50 percent continuous interbedded and intertwined plates of crystalline gypsum; noneffervescent; slightly alkaline (pH 7.6); abrupt irregular boundary.

Cy3—20 to 28 inches; very pale brown (10YR 7/3) extremely channery sand, yellowish brown (10YR 5/6) moist; single grain; loose, nonsticky and nonplastic; common very fine irregular pores; few fine roots; 60 percent weathered gypsite channers; 15 percent gypsite gravel; 10 percent sand-sized gypsum crystals; noneffervescent; slightly alkaline (pH 7.8); abrupt irregular boundary.

Cr—28 inches; gypsite bedrock.

Range in Characteristics

This is a taxadjunct to the soil series. Gypill soils are loamy, but this is loamy-skeletal because of the presence of coarse grained gypsum crystals.

Depth to semi-consolidated lacustrine sediment: 24 to 34 inches

Clay content: 2 to 10 percent

Rock fragments: average more than 35 percent in the particle size control section

Electrical conductivity: 2 to 300 mmhos/cm

Sodium absorption ratio: 0 to 13

Gypsum content: 30 to 90 percent

Reaction: slightly alkaline to moderately alkaline

Calcium carbonate equivalent: 0 to 5 percent

Organic matter content: 0.1 to 1.0 percent

C horizons

Hue: 10YR, 7.5YR, 5YR

Value: 7 or 8 dry, 5 or 6 moist

Chroma: 1 through 8, dry or moist

Meadview soils

Taxonomic classification: sandy-skeletal, mixed, thermic Durinodic Haplocalcids

Geomorphic position: summits and side slopes of fan terraces

Parent material: alluvium

Slope: 2 to 15 percent

Surface fragments: about 60 percent coarse gravel, about 5 percent cobbles, about 3 percent stones

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 1.9

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Medium

Hydrologic group: C

Major Land Resource Area: 30

Land Resource Unit: 30-2

Ecological site name: Limy Upland, Deep 6-9" p.z.

Ecosystem site number: 030XB215AZ

Present native vegetation: white bursage, creosotebush, rayless goldenhead, Indian ricegrass, big galleta, flattop buckwheat

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 1.43 miles northeast of Gyp Wash; 36 degrees, 14 minutes, 55 seconds north latitude; 113 degrees, 55 minutes, 25 seconds west longitude.

A—0 to 2 inches; reddish yellow (7.5YR 6/6) very gravelly sandy loam, strong brown (7.5YR 4/6) moist; weak thick platy structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; common very fine irregular and few fine tubular pores; 40 percent gravel; violently effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bk1—2 to 8 inches; reddish yellow (7.5YR 6/6) gravelly

loam, strong brown (7.5YR 4/6) moist; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and few fine and medium roots; common very fine and few fine tubular pores; 25 percent gravel; violently effervescent; thick coats and pendants of calcium carbonate on the sides and undersides of rock fragments; violently effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bk2—8 to 14 inches; reddish yellow (7.5YR 7/6) very gravelly loam, strong brown (7.5YR 5/6) moist; massive; slightly hard, very friable, moderately sticky and slightly plastic; few very fine roots; few very fine tubular pores; 55 percent gravel; violently effervescent; thick coats of calcium carbonate on the sides and undersides of rock fragments; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

2Bkq—14 to 60 inches; pink (7.5YR 7/4) extremely gravelly loamy coarse sand, strong brown (7.5YR 5/6) moist; massive; hard, brittle, nonsticky and nonplastic; few very fine roots; few very fine irregular pores; 50 percent gravel, 10 percent cobble, 10 percent stone; rock fragments are stratified and variable; common strongly silica cemented lenses; strongly effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Depth to calcic horizon: 2 to 18 inches
 Depth to gravel and sand: 20 to 30 inches
 Depth to brittle silica and calcium carbonate cemented materials: 14 to 40 inches
 Calcium carbonate equivalent: 5 to 30 percent
 Clay content: averages less than 10 percent in the particle size control section
 Rock fragments: average 35 to 75 percent in the particle size control section

A horizon

Hue: 7.5YR, 10YR
 Value: 5 through 7 dry, 4 or 5 moist
 Chroma: 3 through 6, dry or moist

Bk and Bkq horizons

Hue: 10YR, 7.5YR
 Value: 5 through 8 dry, 4 through 6 moist
 Chroma: 4 through 6, dry or moist

45—Haplocalcids-Rock outcrop complex, 1 to 19 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,600 to 5,000 feet (1,097 to 1,524 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 55 to 57 degrees F (13 to 14 degrees C)

Mean annual soil temperature: 57 to 59 degrees F (15 to 16 degrees C)

Frost-free period: 160 to 175 days

Map Unit Composition

Haplocalcids and similar soils: 80 percent

Rock outcrop: 15 percent

Minor components: 5 percent

- Loamy, mixed, active, mesic Lithic Calciargids
- Soils that are frequently flooded in canyon bottoms
- Soils on very steep side slopes of canyons.
- Moenkopi Formation remnants

Properties and Qualities

Haplocalcids soils

Taxonomic classification: Haplocalcids

Geomorphic position: summits, shoulders, and sideslopes of canyons

Parent material: colluvium and/or loamy pedisegment derived from calcareous sandstone

Slope: 1 to 19 percent

Depth to restrictive feature: 6 to 43 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-2

Ecological site name: Gravelly Upland, Alkaline 6-10" p.z.

Ecosystem site number: 035XB233AZ

Present native vegetation: shadscale saltbush, Sporobolus, galleta, ephedra, Opuntia

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Marble Platform; 2,949 feet northeast of Ah Hol Sah; 36 degrees, 40 minutes, 15 seconds north latitude; 111 degrees, 40 minutes, 34 seconds west longitude.

A—0 to 2 inches; reddish brown (5YR 5/4) gravelly fine sandy loam, reddish brown (5YR 4/4) moist; moderate fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; common very fine and few fine and medium roots; common very fine vesicular pores; violently effervescent; 15 percent gravel; strongly alkaline (pH 8.8); abrupt smooth boundary.

AB—2 to 10 inches; pink (5YR 7/4) gravelly fine sandy loam, yellowish red (5YR 5/6) moist; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few medium, common fine, and medium very fine roots; many fine dendritic tubular, few very fine vesicular pores; violently effervescent; 20 percent gravel; strongly alkaline (pH 8.8); clear smooth boundary

Bk1—10 to 14 inches; pinkish white (5YR 8/2) very gravelly loam, pink (5YR 7/4) moist; moderate coarse subangular blocky structure; hard, friable, moderately sticky and slightly plastic; many very fine and fine roots; few very fine and fine dendritic tubular pores; matrix plugged with soft carbonates; violently effervescent; 25 percent gravel, 10 percent cobble; strongly alkaline (pH 8.8); gradual wavy boundary.

Bk2—14 to 23 inches; white (7.5YR 8/1) extremely channery loam, pink (7.5YR 7/4) moist; weak coarse subangular blocky structure; very hard, firm, moderately sticky and slightly plastic; few fine roots; few very fine dendritic tubular pores; matrix plugged with carbonates (moderately cemented); violently effervescent; 15 percent gravel, 70 percent channer-size petrocalcic fragments; strongly alkaline (pH 9.0); very abrupt smooth boundary.

2R—23 inches; white (7.5YR 8/1) limestone of the Kaibab Formation, pink (7.5YR 7/4) moist.

Range in Characteristics

These soils are highly variable with respect to depth, color, and rock fragment content.

Rock outcrop

Cliffs and exposed rock of arenaceous limestone

46—Hindu-Rock outcrop complex, 5 to 45 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,000 to 4,600 feet (1,219 to 1,402 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 68 degrees F (14 to 20 degrees C)

Mean annual soil temperature: 59 to 70 degrees F (16 to 22 degrees C)

Frost-free period: 180 to 220 days

Map Unit Composition

Hindu and similar soils: 60 percent

Rock outcrop: 20 percent

Minor components: 20 percent

- Moderately deep, gravelly soils
- Deep loamy soils in drainageways
- Soils that have a calcium carbonate cemented hardpan
- Soils that have less rock fragments in the profile
- Soils that have steeper slopes

Properties and Qualities

Hindu soils

Taxonomic classification: Loamy-skeletal, mixed (calcareous), superactive, thermic Lithic Torriorthents

Geomorphic position: summits and side slopes of ridges

Parent material: alluvium and/or colluvium derived from limestone

Slope: 5 to 45 percent

Surface fragments: about 2 percent stones, about 45 percent gravel, about 5 percent cobbles

Depth to restrictive feature: 4 to 19 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 0.8

Shrink-swell potential: about 1.5 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limestone Hills 6-10" p.z.

Ecosystem site number: 035XE505AZ

Present native vegetation: blackbrush, black grama, slim tridens, ephedra, Stansbury cliffrose, Utah agave

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Hualapai Plateau; 3.08 miles northeast of New Water Tank; 36 degrees, 0 minutes, 35 seconds north latitude; 113 degrees, 54 minutes, 51 seconds west longitude.

A—0 to 1 inch; light yellowish brown (10YR 6/4) very gravelly loam; brown (10YR 4/3) moist; moderate thin platy structure; slight hard, very friable; slightly sticky and slightly plastic; few very fine roots; many very fine and fine vesicular pores; 45 percent gravel, 5 percent cobble, and 2 percent stone; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

threads and soft bodies of calcium carbonate; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bk2—11 to 17 inches; reddish yellow (7.5YR 6/6) gravelly loam, strong brown (7.5YR 5/6) moist; moderate medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; few very fine tubular pores; 25 percent gravel; common threads and soft masses of calcium carbonate; violently effervescent; moderately alkaline (pH 8.4); clear irregular boundary.

2Bqk—17 to 60 inches; light brown (7.5YR 6/4) extremely cobbly fine sandy loam, strong brown (7.5YR 4/6) moist; massive; slightly hard, friable, slightly sticky and nonplastic; 35 percent gravel, 20 percent cobble, 10 percent stone; discontinuously strongly cemented and weakly cemented by calcium carbonate and silica; violently effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Depth to calcic horizon: 2 to 6 inches

Depth to silica cementation: 7 to 21 inches

Rock fragments: average 35 to 80 percent in the particle size control section

Calcium carbonate equivalent: 15 to 35 percent in the less than 20 millimeter fraction

A horizon

Hue: 10YR, 7.5YR

Value: 5 through 7 dry, 4 or 5 moist

Chroma: 3 through 6, dry or moist

Bk horizon

Hue: 10YR, 7.5YR

Value: 6 or 7 dry, 4 through 6 moist

Chroma: 3 through 6, dry or moist

Texture: fine sandy loam, loam

2Bqk horizon

Hue: 10YR, 7.5YR

Value: 6 through 8 dry, 4 through 6 moist

Chroma: 2 through 6, dry or moist

Cementation: Discontinuous, weakly silica and calcium carbonate cemented with 20 to 50 percent strong silica and calcium carbonate cementation occurring as concretions, durinodes, or lenses within the matrix. These are hard or very hard when dry, brittle when moist, and do not slake in dilute hydrochloric acid.

Additional features: Some pedons have a weakly silica cemented, stratified C horizon below the Bqk horizon that average coarse sandy loam through loam in the fine earth fraction, modified by 35 to 80 percent coarse fragments, predominantly gravel and cobble.

48—Iceberg-Rock outcrop-Helkitchen association

Map Unit Setting

Landform: plateau

Elevation: 1,200 to 3,200 feet (365 to 975 meters)

Mean annual precipitation: 3 to 9 inches (76 to 229 millimeters)

Mean annual air temperature: 66 to 75 degrees F (19 to 24 degrees C)

Mean annual soil temperature: 68 to 77 degrees F (21 to 26 degrees C)

Frost-free period: 280 to 340 days

Map Unit Composition

Iceberg and similar soils: 45 percent

Rock outcrop: 25 percent

Helkitchen and similar soils: 15 percent

Minor components: 15 percent

- Iceberg extremely stony loam on side slopes in the lower part of the unit

- Loamy-skeletal, carbonatic, thermic Lithic Torriorthents dominated by white bursage and creosotebush

- Loamy-skeletal, carbonatic, thermic Lithic Haplocalcids northerly, upper side slopes dominated by Utah agave and creosotebush

- Loamy-skeletal, carbonatic, hyperthermic Lithic Torriorthents dominated by acacia, burrobrush, and creosotebush

- Soils that have a gravelly surface phase

- Soils that have slopes of less than 30 percent

Properties and Qualities

Iceberg soils

Taxonomic classification: Loamy-skeletal, carbonatic, hyperthermic Lithic Haplocalcids

Geomorphic position: very steep slopes of canyon sidewalls

Parent material: colluvium and/or residuum weathered from limestone

Slope: 8 to 50 percent

Surface fragments: about 50 percent coarse gravel, about 20 percent stones, about 10 percent cobbles

Depth to restrictive feature: 10 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 0.8

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 30

Land Resource Unit: 30-1

Ecological site name: Limestone Hills 3-6" p.z.

Ecosystem site number: 030XA126AZ

Present native vegetation: creosotebush, white brittlebush, white bursage, white ratany

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: South of Iceberg Canyon on the north end of Devils Cove; 36 degrees, 10 minutes, 11 seconds north latitude; 114 degrees, 5 minutes, 8 seconds west longitude.

A—0 to 2 inches; light yellowish brown (10YR 6/4) extremely stony loam, dark yellowish brown (10YR 4/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; common very fine and few fine irregular pores; 50 percent gravel, 10 percent cobble, 25 percent stone; violently effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

Bk1—2 to 7 inches; light yellowish brown (10YR 6/4) extremely gravelly loam, dark yellowish brown (10YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and few fine and medium roots; common very fine and few fine irregular pores; 55 percent gravel, 10 percent cobble, 3 percent stone; common thin coats of calcium carbonate on undersides of rock fragments; violently effervescent; moderately alkaline (pH 8.4) clear wavy boundary.

Bk2—7 to 17 inches; light yellowish brown (10YR 6/4) extremely cobbly loam, dark yellowish brown (10YR 4/4) moist; massive; soft, very friable, slightly sticky and slightly plastic; common very fine and few fine through coarse roots; common very fine irregular pores; 20 percent gravel, 40 percent cobble, 10 percent stone; many thin coats of calcium carbonate on undersides of rock fragments; violently

effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

R—17 inches; hard limestone bedrock.

Range in Characteristics

Depth to calcic horizon: 1 to 3 inches

Depth to bedrock: 10 to 20 inches

Clay content: 8 to 15 percent

Rock fragments: 60 to 85 percent, mainly cobble and stone

Organic matter content: 0.1 to 0.5 percent

A horizon

Value: 5 through 7 dry, 4 or 5 moist

Chroma: 3 or 4, dry or moist

Bk horizons

Hue: 10YR, 7.5YR

Value: 6 or 7 dry, 4 or 5 moist

Chroma: 3 or 4, dry or moist

Calcium carbonate equivalent: 40 to 70 percent in the less than 20 mm fraction; 35 to 60 percent in the fine earth fraction; occurs as common to many thin coats and pendants on rock fragments

Texture: fine sandy loam, loam

Rock outcrop

Escarments of canyons that are mostly vertical consisting of the Muav Formation.

Helkitchen soils

Taxonomic classification: Loamy-skeletal, carbonatic, thermic Lithic Haplocalcids

Geomorphic position: ledges on very steep slopes of canyon sidewalls

Parent material: colluvium and/or residuum weathered from limestone

Slope: 8 to 50 percent

Surface fragments: about 15 percent stones, about 15 percent cobbles, about 40 percent coarse gravel

Depth to restrictive feature: 7 to 14 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 0.6

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 30

Land Resource Unit: 30-2

Ecological site name: Limestone Hills 6-9" p.z.

Ecosystem site number: 030XB210AZ

Present native vegetation: Nevada Mormon tea, big galleta, bush muhly, Opuntia, rayless brittlebush, white ratany, agave

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: South of Iceberg Canyon on the north end of Devils Cove; 36 degrees, 36 degrees, 10 minutes, 11 seconds north latitude; 114 degrees, 5 minutes, 9 seconds west longitude.

A—0 to 3 inches; brown (10YR 5/3) extremely stony fine sandy loam, brown (10YR 4/3) moist; moderate thin platy structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and common fine irregular pores; 15 percent stone, 15 percent cobble; 40 percent gravel; strongly effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bk1—3 to 7 inches; pale brown (10YR 6/3) very gravelly fine sandy loam, brown (10YR 4/3) moist; moderate fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and few fine and medium roots; many very fine irregular pores and common very fine and fine tubular pores; many thin coats and pendants of calcium carbonates on rock fragments; 2 percent cobble, 35 percent gravel; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bk2—8 to 12 inches; light yellowish brown (10YR 6/4) very gravelly fine sandy loam, dark yellowish brown (10YR 4/4) moist; massive; soft, very friable, slightly sticky and moderately plastic; common very fine and fine roots; many very fine irregular and common very fine tubular pores; many thick coats and pendants on sides and undersides of rock fragments; 15 percent cobble, 40 percent gravel; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

2R—12 inches; gray (10YR 8/1) fractured limestone with many thin to thick coats of calcium carbonate in fractures.

Range in Characteristics

Depth to bedrock: 7 to 14 inches

Clay content: averages 10 to 18 percent

Rock fragments: 35 to 60 percent, mostly cobble

Calcium carbonate equivalent: 40 to 80 percent in the less than 20 mm fraction

Organic matter content: 0.1 to 0.5 percent

A horizon

Value: 5 or 6 dry, 4 or 5 moist

Chroma: 3 or 4, dry or moist

Bk horizons

Hue: 10YR, 7.5YR

Value: 5 or 6 dry, 3 through 5 moist

Chroma: 3 or 4, dry or moist

Texture of fine earth: sandy loam, fine sandy loam

49—Kaiparowits gravelly fine sandy loam, 15 to 40 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 8,540 to 9,150 feet (2,602 to 2,789 meters)

Mean annual precipitation: 25 to 33 inches (635 to 838 millimeters)

Mean annual air temperature: 36 to 45 degrees F (2 to 7 degrees C)

Mean annual soil temperature: 38 to 47 degrees F (4 to 9 degrees C)

Frost-free period: 70 to 105 days

Map Unit Composition

Kaiparowits and similar soils: 80 percent

Minor components: 20 percent

- Soils that have no accumulation of clay in the profile
- Soils that have more than 35 percent by volume of rock fragments
- Rock outcrop
- Soils that are shallow to bedrock
- Soils in sinkholes that are very deep and frequently ponded
- Soils in drainageways that are occasionally flooded

Properties and Qualities

Kaiparowits soils

Taxonomic classification: very-fine, smectitic, frigid Oxyaquic Paleustalfs

Geomorphic position: summits and sideslopes of low hills and ridges

Parent material: residuum weathered from calcareous sandstone and/or residuum weathered from cherty limestone

Slope: 15 to 40 percent

Surface fragments: about 20 percent gravel, about 10 percent cobbles, about 10 percent stone

Depth to restrictive feature: 40 to 60 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.03 in/hr (very slow)

Available water capacity total inches: 7.8

Shrink-swell potential: about 7.0 LEP (high)

Flooding hazard: None

Seasonal water table minimum depth: Saturated with water in one or more layers within 40 inches in normal years 20 or more consecutive days or 30 or more cumulative days

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-9

Ecological site name: Loamy Hills, Cold (ABLA, PIEN) 25-33" p.z.

Ecosystem site number: 035XI903AZ

Present native vegetation: Engelmann spruce, quaking aspen, subalpine fir, Douglas-fir, other coniferous trees

Land capability (nonirrigated): 5c

Taxonomic Unit Description

Type Location: On the Kaibab Plateau; 36 degrees, 16 minutes, 14 seconds north latitude; 112 degrees, 6 minutes, 49 seconds west longitude.

Oi—0 to 1 inch; slightly decomposed mixed conifer and aspen litter.

A—1 to 5 inches; pale brown (10YR 6/3) gravelly sandy loam; brown (10YR 4/3) moist; moderate fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and common fine roots; common very fine and few fine tubular pores; 20 percent gravel; noneffervescent; moderately acid (pH 6.0); clear wavy boundary.

E—5 to 15 inches; very pale brown (10YR 7/3) very gravelly fine sandy loam; brown (10YR 5/3) moist; moderate very fine and fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine, common fine and few medium roots; common very fine and fine and few medium tubular pores; 30 percent gravel, 10 percent cobble, and 5 percent stone; noneffervescent; moderately acid (pH 6.0); clear wavy boundary.

Bt/E—15 to 24 inches; strong brown (7.5YR 5/6) very cobbly sandy loam; yellowish red (5YR 4/6) moist; moderate fine and medium subangular blocky structure, hard, friable, slightly sticky and slightly plastic; common thin clay films bridging sand grains (Bt); very pale brown (10YR 7/3) very cobbly sandy loam; brown (10YR 5/3) moist; weak very fine and fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic (E); common very fine and fine and few medium roots; common very fine and fine and few medium tubular pores; few faint clay films bridging sand grains; 15 percent gravel, 20 percent

cobble, and 5 percent stone; noneffervescent; moderately acid (pH 6.0); abrupt wavy boundary.

Bt1—24 to 36 inches; yellowish red (5YR 5/6) cobbly clay; yellowish red (5YR 4/6) moist; moderate medium subangular blocky structure parting to strong fine subangular blocky; hard, friable, moderately sticky and moderately plastic; few very fine and common fine and medium roots; common very fine and few fine and medium tubular pores; many faint clay films bridging sand grains and lining pores; 10 percent gravel, 5 percent cobbles, and 5 percent stones; noneffervescent; strongly acid (pH 5.5); clear smooth boundary.

Bt2—36 to 44 inches; yellowish red (5YR 5/6) cobbly clay; yellowish red (5YR 4/6) moist; moderate medium subangular blocky structure parting to strong fine subangular blocky; hard, firm, moderately sticky and moderately plastic; few very fine and fine and common medium roots; common very fine and few fine and medium tubular pores; many faint clay films bridging sand grains and lining pores, common thin clay films on faces of peds; 5 percent gravel, 10 percent cobble, and 5 percent stone; noneffervescent; strongly acid (pH 5.5); abrupt wavy boundary.

Bt3—44 to 58 inches; red (2.5YR 5/6) very flaggy clay; reddish brown (2.5YR 4/4) moist; moderate medium subangular blocky structure parting to moderate fine subangular blocky; hard, firm, moderately sticky and moderately plastic; few fine and medium roots; few very fine and fine tubular pores; many faint clay films bridging sand grains and lining pores, common faint clay films on faces of peds; 20 percent gravel, 10 percent channers, and 25 percent flagstone (channers and flagstone are slightly displaced from horizontal); noneffervescent; strongly acid (pH 5.5).

R—58 inches; cherty sandstone bedrock.

Range in Characteristics

Particle size control section (weighted average): clay content 65 to 75 percent; Rock fragments 5 to less than 35 percent

Depth to bedrock: 40 to 60 inches

Depth to argillic: 14 to 40 inches

A horizon(s)

Hue: 7.5YR, 10YR

Value: 3 through 6 dry, 3 through 5 moist

Chroma: 2 through 4, dry or moist

Reaction: strongly acid to neutral

E horizon

Hue: 7.5YR, 10YR

Value: 5 through 7 dry, 4 through 6 moist

Chroma: 3 dry, 3 or 4 moist
 Clay content: 8 to 15 percent
 Rock fragments: 20 to 70 percent
 Reaction: strongly acid to neutral

Bt horizon(s)

Hue: 2.5YR, 5YR, 7.5YR
 Value: 3 through 6 dry, 3 through 5 moist
 Chroma: 4 through 6, dry or moist
 Reaction: very strongly acid to slightly acid
 Some pedons have Bt/E or E/Bt horizons.

50—Kaiparowits-Plite family complex, 2 to 8 percent slopes

Map Unit Setting

Landform: plateau
Elevation: 8,000 to 8,540 feet (2,432 to 2,602 meters)
Mean annual precipitation: 25 to 33 inches (635 to 838 millimeters)
Mean annual air temperature: 36 to 45 degrees F (2 to 7 degrees C)
Mean annual soil temperature: 38 to 47 degrees F (4 to 9 degrees C)
Frost-free period: 80 to 100 days

Map Unit Composition

Kaiparowits and similar soils: 50 percent
 Plite family and similar soils: 40 percent
 Minor components: 10 percent

- Soils that have no accumulation of clay in the profile
- Soils that have more than 35 percent by volume of rock fragments
- Rock outcrop
- Soils that are shallow to bedrock
- Soils in sinkholes that are very deep and frequently ponded
- Soils in drainageways that are occasionally flooded

Properties and Qualities

Kaiparowits soils

Taxonomic classification: very-fine, smectitic, frigid Oxyaquic Paleustalfs
Geomorphic position: summits and sideslopes of low hills and ridges
Parent material: residuum weathered from cherty limestone and/or residuum weathered from calcareous sandstone
Slope: 2 to 8 percent
Surface fragments: about 5 percent gravel

Depth to restrictive feature: 40 to 60 inches to bedrock (lithic)
Drainage class: Well drained
Permeability: about 0.03 in/hr (very slow)
Available water capacity total inches: 4.8
Shrink-swell potential: about 7.0 LEP (high)
Flooding hazard: None
Seasonal water table minimum depth: Saturated with water in one or more layers within 40 inches in normal years 20 or more consecutive days or 30 or more cumulative days
Runoff class: High
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-9
Ecological site name: Loamy Hills (ABCO, PIPO, POTR5) 25-33" p.z.
Ecosystem site number: 035XI902AZ
Present native vegetation: quaking aspen, white fir, ponderosa pine, Ross sedge, other coniferous trees
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Kaibab Plateau; 1,745 feet west of The Basin; 36 degrees, 16 minutes, 14 seconds north latitude; 112 degrees, 6 minutes, 49 seconds west longitude.

A—0 to 4 inches; brown (7.5YR 5/3) loam; dark brown (7.5YR 3/3) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; common very fine irregular pores; 2 percent gravel; noneffervescent; slightly acid (pH 6.4); abrupt smooth boundary.

Bw1—4 to 9 inches; brown (7.5YR 5/3) loam; dark brown (7.5YR 3/3) moist; moderate medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine roots; common fine tubular pores; 2 percent gravel; noneffervescent; slightly acid (pH 6.2); clear smooth boundary.

Bw2—9 to 22 inches; reddish brown (5YR 5/4) loam; reddish brown (5YR 4/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and medium roots; common fine tubular pores; 10 percent gravel; noneffervescent; slightly acid (pH 6.2); clear wavy boundary.

Bt—22 to 41 inches; reddish brown (2.5YR 4/4) clay; reddish brown (2.5YR 4/4) moist; weak medium prismatic structure parting to strong fine and medium angular blocky; hard, firm, very sticky and very plastic;

few fine roots; few fine tubular pores; many distinct clay films lining pores and on the faces of peds; 10 percent gravel; slightly effervescent; neutral (pH 7.2); abrupt irregular boundary.

R—41 inches; sandstone bedrock.

Range in Characteristics

Clay content (control section): 35 to 55 percent
 Rock fragment content (control section): 5 percent to less than 35 percent
 Depth to bedrock: 40 to 60 inches

A horizon

Hue: 7.5YR, 10YR
 Value: 3 through 6 dry, 3 through 5 moist
 Chroma: 2 through 4, dry or moist
 Reaction: strongly acid to neutral

Bt horizon(s)

Hue: 2.5YR, 5YR, 7.5YR
 Value: 3 through 6 dry, 3 through 5 moist
 Chroma: 4 or 6, dry or moist
 Reaction: very strongly acid to neutral

Some pedons have Bt/E or E/Bt horizons.

Some pedons have zones of redoximorphic concentrations containing partially to strongly cemented iron-manganese oxide nodules and noncemented masses, and weakly expressed zones of redoximorphic depletions (E, Bt, and Bt/Cr horizons).

Plite family soils

Taxonomic classification: Coarse-loamy, mixed, superactive, frigid Cumulic Haplustolls
Geomorphic position: fan terraces at the toe slopes of hills and escarpments
Parent material: alluvium
Slope: 2 to 8 percent
Depth to restrictive feature: 40 to 60 inches to bedrock (lithic)
Drainage class: Well drained
Permeability: about 4.00 in/hr (moderately rapid)
Available water capacity total inches: 6.7
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: Medium
Hydrologic group: B
Major Land Resource Area: 35
Land Resource Unit: 35-9
Ecological site name: Loamy Upland 25-33" p.z.

Ecosystem site number: 035XI905AZ

Present native vegetation: mountain muhly, Carex, big wildrye, sheep fescue, pine dropseed

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Kaibab Plateau; 2,068 feet west of The Basin; 36 degrees, 16 minutes, 8 seconds north latitude; 112 degrees, 6 minutes, 53 seconds west longitude.

A—0 to 3 inches; brown (10YR 5/3) gravelly loam; very dark grayish brown (10YR 3/2) moist; weak fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; common fine tubular pores; 20 percent gravel; noneffervescent; moderately acid (pH 5.8); abrupt smooth boundary.

Bw1—3 to 15 inches; brown (10YR 5/3) gravelly loam; dark brown (10YR 3/3) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine, many fine and common medium and coarse roots; common fine tubular pores; 25 percent gravel; noneffervescent; moderately acid (pH 5.8); clear smooth boundary.

Bw2—15 to 35 inches; brown (10YR 5/3) gravelly loam; very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common fine through coarse roots; common fine and few medium tubular pores; 20 percent gravel; noneffervescent; moderately acid (pH 5.8); clear smooth boundary.

Bw3—35 to 45 inches; light yellowish brown (10YR 6/4) gravelly loam; yellowish brown (10YR 5/4) moist; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common fine and medium roots; common very fine and fine irregular pores; 20 percent gravel; noneffervescent; moderately acid (pH 5.8); abrupt irregular boundary.

R—45 inches; sandstone bedrock.

Range in Characteristics

Thickness of the mollic epipedon: 16 to 38 inches
 Depth to bedrock: 40 to 60 inches or more
 Reaction: moderately acid to neutral

A horizon

Hue: 7.5YR, 10YR
 Value: 4 or 5 dry, 2 to 3 moist
 Chroma: 2 to 3, dry or moist

Bw horizon(s)

Hue: 7.5YR, 10YR
 Value: 3 through 6 dry, 3 through 5 moist
 Chroma: 2 through 4, dry or moist
 Clay content: 12 to 15 percent
 Rock fragments: 0 to 25 percent gravel

51—Kanabownits fine sandy loam, 15 to 40 percent slopes

Map Unit Setting

Landform: plateau
Elevation: 8000 to 8,540 feet (2,438 to 2,602 meters)
Mean annual precipitation: 25 to 33 inches (635 to 838 millimeters)
Mean annual air temperature: 36 to 45 degrees F (2 to 7 degrees C)
Mean annual soil temperature: 38 to 47 degrees F (4 to 9 degrees C)
Frost-free period: 70 to 105 days

Map Unit Composition

Kanabownits and similar soils: 80 percent
 Minor components: 20 percent

- Soils that have no accumulation of clay in the profile
- Soils that have more than 35 percent by volume of rock fragments
- Rock outcrop
- Soils that are shallow to bedrock
- Soils in sinkholes that are very deep and frequently ponded
- Soils in drainageways that are occasionally flooded

Properties and Qualities

Kanabownits soils

Taxonomic classification: Loamy-skeletal, mixed, semiactive, nonacid, frigid Oxyaquic Ustorthents
Geomorphic position: summits and sideslopes of low hills and ridges
Parent material: residuum weathered from cherty limestone and/or residuum weathered from calcareous sandstone
Slope: 15 to 40 percent
Surface fragments: about 5 percent gravel
Depth to restrictive feature: 40 to 60 inches to bedrock (lithic)
Drainage class: Well drained
Permeability: about 4.00 in/hr (moderately rapid)
Available water capacity total inches: 4.5
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None

Seasonal water table minimum depth: Saturated with water in one or more layers within 40 inches in normal years 20 or more consecutive days or 30 or more cumulative days

Runoff class: Medium

Hydrologic group: B

Major Land Resource Area: 35

Land Resource Unit: 35-9

Ecological site name: Loamy Hills (ABCO, PIPO, POTR5) 25-33" p.z.

Ecosystem site number: 035XI902AZ

Present native vegetation: quaking aspen, white fir, ponderosa pine, Ross sedge, other coniferous trees

Land capability (nonirrigated): 5c

Taxonomic Unit Description

Type Location: On the Kaibab Plateau; 36 degrees, 14 minutes, 28 seconds north latitude; 112 degrees, 3 minutes, 26 seconds west longitude.

Oi—0 to 1 inch; partially decomposed conifer and grass litter.

A—1 to 5 inches; brown (10YR 5/3) fine sandy loam; dark brown (10YR 3/3) moist; weak very fine and fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and common fine roots; common very fine and few fine tubular pores; 5 percent gravel; noneffervescent; neutral (pH 6.8); clear smooth boundary.

AE—5 to 11 inches; dark yellowish brown (10YR 4/4) fine sandy loam; dark yellowish brown (10YR 4/4) moist; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine and few medium roots; common very fine and fine tubular pores; 5 percent gravel; noneffervescent; neutral (pH 6.6); clear smooth boundary.

E1—11 to 20 inches; brownish yellow (10YR 6/6) fine sandy loam; dark yellowish brown (10YR 4/4) moist; moderate fine and medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common very fine and few fine through coarse roots; few very fine through medium tubular pores; 10 percent gravel, noneffervescent; slightly acid (pH 6.4); clear wavy boundary.

E2—20 to 28 inches; brownish yellow (10YR 6/6) very cobbly fine sandy loam; dark yellowish brown (10YR 4/4) moist; moderate fine and medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few fine through coarse roots; common

fine tubular pores; 20 percent gravel, 15 percent cobble, and 10 percent stone; noneffervescent; slightly acid (pH 6.4); clear wavy boundary.

E3—28 to 57 inches; yellow (10YR 7/6) very gravelly fine sandy loam; yellowish brown (10YR 5/6) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few fine through coarse roots; few fine tubular pores; 30 percent gravel, 5 percent cobble, and 5 percent stone; noneffervescent; slightly acid (pH 6.2).

R—57 inches; sandstone bedrock.

Range in Characteristics

Reaction: moderately acid to neutral

Depth to bedrock: 40 to 60 inches

Saturation: the zone below 36 inches is saturated with water from snowmelt for 20 or more consecutive days or 30 or more cumulative days in the months of March and April.

Clay content (control section): 8 to 18 percent

Rock fragment content (control section): greater than 35 percent

A horizon(s)

Hue: 10YR, 7.5YR

Value: 3 through 6 dry, 2 through 4 moist

Chroma: 2 or 3, dry or moist

E horizon(s)

Hue: 10YR, 7.5YR

Value: 6 or 7 dry, 4 through 6 moist

Chroma: 3 through 6, dry or moist

Some pedons have Cr horizons.

Some pedons may have iron concentrations and redoximorphic features in the lower part.

52—Kanabownits-Kippers-Kaiparowits complex, 2 to 15 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 8,000 to 8,540 feet (2,438 to 2,602 meters)

Mean annual precipitation: 25 to 33 inches (635 to 838 millimeters)

Mean annual air temperature: 36 to 45 degrees F (2 to 7 degrees C)

Mean annual soil temperature: 38 to 47 degrees F (4 to 9 degrees C)

Frost-free period: 70 to 105 days

Map Unit Composition

Kanabownits and similar soils: 40 percent

Kippers and similar soils: 30 percent

Kaiparowits and similar soils: 25 percent

Minor components: 5 percent

- Soils that have no accumulation of clay in the profile
- Soils that have more than 35 percent by volume of rock fragments
- Rock outcrop
- Soils that are shallow to bedrock
- Soils in sinkholes that are very deep and frequently ponded
- Soils in drainageways that are occasionally flooded

Properties and Qualities

Kanabownits soils

Taxonomic classification: Loamy-skeletal, mixed, semiactive, nonacid, frigid Oxyaquic Ustorthents

Geomorphic position: summits and sideslopes of low hills and ridges

Parent material: residuum weathered from calcareous sandstone and/or residuum weathered from cherty limestone

Slope: 2 to 15 percent

Surface fragments: about 35 percent gravel, about 25 percent cobbles

Depth to restrictive feature: 40 to 60 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 2.7

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: Saturated with water in one or more layers within 40 inches in normal years 20 or more consecutive days or 30 or more cumulative days

Runoff class: Medium

Hydrologic group: B

Major Land Resource Area: 35

Land Resource Unit: 35-9

Ecological site name: Loamy Hills (ABCO, PIPO, POTR5) 25-33" p.z.

Ecosystem site number: 035XI902AZ

Present native vegetation: quaking aspen, white fir, ponderosa pine, Ross sedge, other coniferous trees

Land capability (nonirrigated): 5c

Taxonomic Unit Description

Type Location: On the Kaibab Plateau; 3,802 feet north

of Marble Flats; 36 degrees, 14 minutes, 32 seconds north latitude; 112 degrees, 4 minutes, 34 seconds west longitude.

Oe—0 to 1 inch; moderately decomposed conifer and aspen litter.

A1—1 to 5 inches; grayish brown (10YR 5/2) very cobbly loam; very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine and common medium roots; common very fine and few fine tubular pores; 35 percent gravel, 15 percent cobble; neutral (pH 6.6); abrupt smooth boundary.

A2—5 to 13 inches; pale brown (10YR 6/3) very cobbly loam; brown (10YR 4/3) moist; moderate fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; common very fine through medium and few coarse roots; common very fine and few fine tubular pores; 35 percent gravel, 20 percent cobble; neutral (pH 6.8); clear wavy boundary.

A3—13 to 22 inches; pale brown (10YR 6/3) very cobbly loam; brown (10YR 4/3) moist; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; common very fine and fine and few medium and coarse roots; common very fine and few fine tubular pores; 30 percent gravel, 25 percent cobble; neutral (pH 7.2); clear wavy boundary.

AE—22 to 26 inches; pale brown (10YR 6/3) extremely cobbly fine sandy loam; brown (10YR 4/3) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine and few medium and coarse roots; few very fine and fine tubular pores; 35 percent gravel, 30 percent cobble; neutral (pH 7.0); clear wavy boundary.

E—26 to 41 inches; very pale brown (10YR 7/3) very cobbly fine sandy loam; pale brown (10YR 6/3) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; few very fine tubular pores; 20 percent gravel, 35 percent cobble; rock fragments range from nonweathered to moderately weathered; neutral (pH 7.2); abrupt wavy boundary.

ECr—41 to 46 inches; very pale brown (10YR 7/4) very cobbly fine sandy loam; light yellowish brown (10YR 6/4) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; few very fine tubular pores; 25 percent gravel, 30 percent cobble; rock fragments are moderately to highly weathered with clay forming in fractures and on faces; neutral (pH 6.7); abrupt wavy boundary.

R—46 inches; sandstone bedrock.

Range in Characteristics

Reaction: moderately acid to neutral

Depth to bedrock: 40 to 60 inches

Saturation: the zone below 30 inches is saturated with water from snowmelt for 20 or more consecutive days or 30 or more cumulative days in the months of March and April.

Clay content (control section): 8 to 18 percent

Rock fragment content (control section): greater than 35 percent

A horizon(s)

Hue: 10YR, 7.5YR

Value: 3 through 6 dry, 2 through 4 moist

Chroma: 2 or 3, dry or moist

E horizon(s)

Hue: 10YR, 7.5YR

Value: 6 or 7 dry, 4 through 6 moist

Chroma: 3 to 4, dry or moist

Some pedons have Cr horizons.

Some pedons may have iron concentrations and redox features in the lower part.

Kippers soils

Taxonomic classification: Fine, smectitic, frigid Aquic Paleustalfs

Geomorphic position: summits and sideslopes of low hills and ridges

Parent material: residuum weathered from calcareous sandstone and/or residuum weathered from cherty limestone

Slope: 2 to 15 percent

Surface fragments: about 45 percent gravel, about 5 percent cobbles

Depth to restrictive feature: 40 to 60 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.03 in/hr (very slow)

Available water capacity total inches: 5.4

Shrink-swell potential: about 7.0 LEP (high)

Flooding hazard: None

Seasonal water table minimum depth: about 28 inches

Runoff class: Medium

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-9

Ecological site name: Loamy Hills (ABCO, PIPO, POTR5) 25-33" p.z.

Ecosystem site number: 035XI902AZ

Present native vegetation: quaking aspen, white fir,

ponderosa pine, Ross sedge, other coniferous trees

Land capability (nonirrigated): 5c

Taxonomic Unit Description

Type Location: On the Kaibab Plateau, 3,400 feet southeast of Vista Encantada; 36 degrees, 13 minutes, 25 seconds north latitude; 111 degrees, 57 minutes, 54 seconds west longitude.

Oi—0 to 1 inch; partially decomposed mixed conifer litter.

A—1 to 5 inches; brown (7.5 YR 4/3) sandy clay loam; very dark brown (7.5YR 2.5/2) moist; weak thin platy structure parting to strong thin and moderately thick platy; hard, very friable, nonsticky and nonplastic; many very fine and fine and common medium roots; common very fine and fine tubular and common very fine irregular pores; 10 percent gravel; noneffervescent; moderately acid (pH 6.0); abrupt wavy boundary.

Bt—5 to 10 inches; reddish brown (5YR 4/3) clay; yellowish red (5YR 4/6) moist; strong medium prismatic structure parting to strong fine and medium angular blocky; very hard, firm, very sticky and very plastic; common very fine and fine and many medium and coarse and few very coarse roots; few very fine and fine tubular pores; common vertical cracks spaced approximately 3 inches apart; many distinct clay films lining pores and on the faces of pedis; continuous pressure faces; 5 percent gravel; common fine faint reddish brown (2.5YR 4/3) redox features; noneffervescent; slightly acid (pH 6.2); clear wavy boundary.

Btss1—10 to 26 inches; yellowish brown (10YR 5/4) clay; yellowish brown (10YR 5/4) moist; strong coarse prismatic structure; very hard, very firm; very sticky and very plastic; few very fine and common fine and medium and many coarse and very coarse roots; common fine tubular pores; common slickensides; few distinct clay films lining pores; continuous pressure faces; common vertical cracks spaced 2.5 to 3.5 inches apart; 5 percent gravel; many fine distinct strong brown (7.5YR 5/6) redox features; few fine light gray (10YR 7/2) depletion zones; noneffervescent; slightly acid (pH 6.1); clear wavy boundary.

Btss2—26 to 35 inches; brown (7.5YR 5/4) clay; brown (7.5YR 5/4) moist; moderate coarse prismatic structure parting to strong fine and medium angular blocky; very hard, firm, very sticky and very plastic; few very fine and fine roots; few very fine and fine tubular pores; common slickensides; common prominent clay films on the faces of pedis; 5 percent gravel; many coarse

prominent red (2.5YR 4/8) redox features; few fine pale red (2.5YR 7/2) depletion zones; noneffervescent; very strongly acid (pH 4.8); gradual wavy boundary.

C/Bt—35 to 46 inches; yellowish red (5YR 5/8) sandy loam; yellowish red (5YR 5/8) moist; massive; hard, friable, slightly sticky and slightly plastic; many very fine and fine irregular pores; common fine faint red (2.5YR 5/6) redox features; common pinkish white (7.5YR 8/2) depletion zones along root channels; extremely acid (pH 4.2) (C); reddish brown (2.5YR 4/4)

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Parent material: residuum weathered from cherty limestone and/or residuum weathered from calcareous sandstone

Slope: 2 to 15 percent

Surface fragments: about 45 percent gravel, about 5 percent cobbles

Depth to restrictive feature: 40 to 60 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.03 in/hr (very slow)

Available water capacity total inches: 3.3

Shrink-swell potential: about 7.0 LEP (high)

Flooding hazard: None

Seasonal water table minimum depth: about 60 inches

Runoff class: Medium

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-9

Ecological site name: Loamy Hills (ABCO, PIPO, POTR5) 25-33" p.z.

Ecosystem site number: 035XI902AZ

Present native vegetation: quaking aspen, white fir, ponderosa pine, Ross sedge, other coniferous trees

Land capability (nonirrigated): 5c

Taxonomic Unit Description

Type Location: On the Kaibab Plateau; 2,047 feet west of Swamp Ridge; 36 degrees, 16 minutes, 34 seconds north latitude; 112 degrees, 4 minutes, 41 seconds west longitude.

Oi—0 to 2 inches; slightly decomposed mixed conifer litter.

Oe—2 to 3 inches; moderately decomposed mixed conifer litter.

A1—3 to 6 inches; very dark grayish brown (10YR 3/2) very gravelly loam; very dark grayish brown (10YR 3/2) moist; strong fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine tubular pores; 50 percent gravel, 5 percent cobble; noneffervescent; neutral (pH 6.6); abrupt wavy boundary.

A2—6 to 12 inches; grayish brown (10YR 5/2) extremely gravelly loam; dark grayish brown (10YR 4/2) moist; moderate medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and common medium roots; many very fine and fine, common medium and few coarse tubular pores; 65 percent gravel, 5 percent cobble; noneffervescent, neutral (pH 6.8); clear wavy boundary.

E1—12 to 25 inches; pink (7.5YR 7/3) extremely gravelly sandy loam; brown (7.5YR 5/3) moist; moderate medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine through coarse roots; common very fine through coarse tubular pores; 65 percent gravel, 5 percent cobble; noneffervescent; neutral (pH 7.0); clear wavy boundary.

E2—25 to 38 inches; pink (7.5YR 7/3) extremely gravelly sandy loam; light brown (7.5YR 6/3) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine through coarse roots; common very fine through coarse tubular pores; 70 percent gravel, 5 percent cobble; noneffervescent; neutral (pH 7.2); abrupt irregular boundary.

Bt—38 to 46 inches; strong brown (7.5YR 5/6) gravelly clay; strong brown (7.5YR 4/6) moist; weak medium prismatic structure parting to strong fine angular blocky; very hard, very firm, very sticky and very plastic; few fine roots, few fine tubular pores; common prominent clay films on the faces of peds; 30 percent gravel, moderate medium redox depletions and masses in the upper inch, noneffervescent; strong acid (pH 5.3); abrupt smooth boundary.

R—46 inches; weathered chert and sandstone bedrock.

Range in Characteristics

Particle size control section (weighted average): clay content 60 to 75 percent; Rock fragments 5 to less than 35 percent

Depth to bedrock: 40 to 60 inches

Depth to argillic: 14 to 40 inches

A horizon(s)

Hue: 7.5YR, 10YR

Value: 3 through 6 dry, 3 through 5 moist

Chroma: 2 through 4, dry or moist

Reaction: strongly acid to neutral

E horizon

Hue: 7.5YR, 10YR

Value: 5 through 7 dry, 4 through 6 moist

Chroma: 3 dry, 3 or 4 moist

Clay content: 8 to 15 percent

Rock fragments: 20 to 70 percent

Reaction: strongly acid to neutral

Bt horizon(s)

Hue: 2.5YR, 5YR, 7.5YR

Value: 3 through 6 dry, 3 through 5 moist

Chroma: 4 through 6, dry or moist

Reaction: very strongly acid to slightly acid

Some pedons have Bt/E or E/Bt horizons.

53—Kanabownits-Kippers-Kaiparowits complex, cool, 2 to 15 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 8,540 to 9,150 feet (2,602 to 2,789 meters)

Mean annual precipitation: 25 to 33 inches (635 to 838 millimeters)

Mean annual air temperature: 36 to 45 degrees F (2 to 7 degrees C)

Mean annual soil temperature: 38 to 47 degrees F (4 to 9 degrees C)

Frost-free period: 70 to 105 days

Map Unit Composition

Kanabownits and similar soils: 35 percent

Kippers and similar soils: 30 percent

Kaiparowits and similar soils: 25 percent

Minor components: 10 percent

- Soils that have no accumulation of clay in the profile
- Soils that have more than 35 percent by volume of rock fragments
- Rock outcrop
- Soils that are shallow to bedrock
- Soils in sinkholes that are very deep and frequently ponded
- Soils in drainageways that are occasionally flooded

Properties and Qualities

Kanabownits soils

Taxonomic classification: Loamy-skeletal, mixed, semiactive, nonacid, frigid Oxyaquic Ustorthents

Geomorphic position: summits and sideslopes of low hills and ridges

Parent material: residuum weathered from calcareous sandstone and/or residuum weathered from cherty limestone

Slope: 2 to 15 percent

Surface fragments: about 5 percent cobbles, about 45 percent gravel

Depth to restrictive feature: 40 to 60 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 3.4

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: Saturated with

water in one or more layers within 40 inches in normal years 20 or more consecutive days or 30 or more cumulative days

Runoff class: Medium

Hydrologic group: B

Major Land Resource Area: 35

Land Resource Unit: 35-9

Ecological site name: Loamy Hills, Cold (ABLA, PIEN) 25-33" p.z.

Ecosystem site number: 035XI903AZ

Present native vegetation: Engelmann spruce, quaking aspen, subalpine fir, Douglas-fir, other coniferous trees

Land capability (nonirrigated): 5c

Taxonomic Unit Description

Type Location: On the Kaibab Plateau; 4,700 feet east of the Grand Canyon National Park North Rim Entrance Station; 36 degrees, 20 minutes, 21 seconds north latitude; 112 degrees, 6 minutes, 0 seconds west longitude.

A1—0 to 6 inches; grayish brown (10YR 5/2) very gravelly fine sandy loam, very dark grayish brown (10YR 3/2) moist; moderate thick platy structure parting to weak fine subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and few fine roots; many very fine tubular pores; 35 percent gravel and 5 percent cobbles; noneffervescent; moderately acid (pH 5.8); abrupt smooth boundary

A2—6 to 19 inches; light yellowish brown (10YR 6/4) very gravelly fine sandy loam, dark yellowish brown (10YR 4/4) moist; moderate fine and medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine, many medium and coarse roots; many very fine tubular pores; 35 percent gravel and 5 percent cobbles; noneffervescent; moderately acid (pH 5.8); clear smooth boundary

E1—19 to 31 inches; pink (7.5YR 7/4) very cobbly fine sandy loam, brown (7.5YR 4/4) moist; weak fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine, fine, medium, and coarse roots; many very fine tubular pores; 30 percent gravel, and 20 percent cobbles; noneffervescent; moderately acid (pH 5.8); clear wavy boundary

E2—31 to 49 inches; reddish yellow (7.5YR 7/6) very cobbly fine sandy loam, strong brown (7.5YR 5/6) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; many very fine tubular pores; 20 percent gravel, and 40 percent

cobbles; noneffervescent; moderately acid (pH 5.8); abrupt wavy boundary

R—49 inches; sandstone bedrock

Range in Characteristics

Reaction: moderately acid to neutral

Depth to bedrock: 40 to 60 inches

Saturation: the zone below 30 inches is saturated with water from snowmelt for 20 or more consecutive days or 30 or more cumulative days in the months of March and April.

Clay content (control section): 8 to 18 percent

Rock fragment content (control section): greater than 35 percent

A horizon(s)

Hue: 10YR, 7.5YR

Value: 3 through 6 dry, 2 through 4 moist

Chroma: 2 or 3, dry or moist

E horizon(s)

Hue: 10YR, 7.5YR

Value: 4 through 7 dry, 4 through 6 moist

Chroma: 3 to 4, dry or moist

Some pedons have Cr horizons.

Some pedons may have iron concentrations and redox features in the lower part.

Kippers soils

Taxonomic classification: Fine, smectitic, frigid Aquic Paleustalfs

Geomorphic position: summits and sideslopes of low hills and ridges

Parent material: residuum weathered from calcareous sandstone and/or residuum weathered from cherty limestone

Slope: 2 to 15 percent

Surface fragments: about 45 percent gravel, about 5 percent cobbles

Depth to restrictive feature: 40 to 60 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.03 in/hr (very slow)

Available water capacity total inches: 7.6

Shrink-swell potential: about 7.0 LEP (high)

Flooding hazard: None

Seasonal water table minimum depth: about 31 inches

Runoff class: Medium

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-9

Ecological site name: Loamy Hills, Cold (ABLA, PIEN) 25-33" p.z.

Ecosystem site number: 035XI903AZ

Present native vegetation: Engelmann spruce, quaking aspen, subalpine fir, Douglas-fir, other coniferous trees

Land capability (nonirrigated): 5c

Taxonomic Unit Description

Type Location: On the Kaibab Plateau; 1.08 miles west of Neal Spring; 36 degrees, 15 minutes, 35 seconds north latitude; 112 degrees, 1 minute, 14 seconds west longitude.

A1—0 to 6 inches; brown (7.5YR 5/4) loam; dark brown (7.5YR 3/4) moist; weak fine subangular blocky structure parting to strong very fine granular; soft, very friable, slightly sticky and slightly plastic; common fine through coarse roots; many very fine and fine irregular and tubular pores; 10 percent gravel; noneffervescent; slightly alkaline (pH 7.8); clear smooth boundary.

A2—6 to 14 inches; brown (7.5YR 5/4) gravelly loam; dark brown (7.5YR 3/4) moist; moderate medium and coarse subangular blocky structure; slightly hard, moderately friable, slightly sticky and slightly plastic; many fine through coarse roots; common very fine through medium and few coarse tubular pores; 25 percent gravel; noneffervescent; slightly alkaline (pH 7.6); abrupt wavy boundary.

Bt—14 to 30 inches; reddish yellow (7.5YR 6/6) clay; brown (7.5YR 5/6) moist; moderate coarse prismatic structure parting to strong fine angular blocky; very hard, very firm, moderately sticky and very plastic; few fine through coarse roots; common medium and coarse tubular pores; common distinct clay films on the faces of peds; 5 percent gravel; many coarse pinkish gray (7.5YR 7/2) redox depletions and few fine concentrations; noneffervescent; slightly alkaline (pH 7.4); clear wavy boundary.

Btss—30 to 43 inches; yellowish red (5YR 5/6) clay; yellowish red (5YR 4/6) moist; moderate medium prismatic structure parting to strong fine angular blocky; very hard, very firm, moderately sticky and very plastic; few fine and medium roots; few fine and medium tubular pores; common slickensides; many distinct clay films on the faces of peds; 5 percent gravel; few fine brown (7.5YR 5/2) redox depletions; noneffervescent; slightly acid (pH 6.1); gradual wavy boundary.

Bt'—43 to 59 inches; yellowish red (5YR 5/6) gravelly clay; yellowish red (5YR 4/6) moist; weak coarse prismatic structure parting to moderate fine angular blocky; very hard, very firm, moderately sticky and very plastic; few fine and medium roots; few fine and medium tubular pores; common faint clay films on the

faces of peds; 20 percent gravel; many medium brown (7.5YR 5/2) redox depletions; noneffervescent; strongly acid (pH 5.3); 55 percent base saturation.

R—59 inches, sandstone bedrock.

Range in Characteristics

Particle size control section (weighted average): clay content—40 to 55 percent, Rock fragments—5 to less than 35 percent

Depth to bedrock: 40 to 60 inches

Depth to argillic: 5 to 14 inches

A horizon(s)

Hue: 7.5YR, 10YR

Value: 4 through 6 dry, 2.5 through 4 moist

Chroma: 3 or 4 dry, 2 through 4 moist

Reaction: strongly acid to slightly alkaline

When colors are dark enough, the A horizon does not meet thickness criteria for a mollic epipedon.

Bt horizon(s)

Hue: 5YR, 7.5YR, or 10YR

Value: 4 to 6, dry or moist

Chroma: 4 through 6, dry or moist

Reaction: very strongly acid to slightly alkaline

Redoximorphic features: few to many, fine through coarse, faint through prominent redox features; few to many, fine through coarse, faint to distinct depletion zones with a chroma of 2 or less.

Some argillic horizons may lack slickensides.

Some pedons have E horizons.

Kaiparowits soils

Taxonomic classification: very-fine, smectitic, frigid Oxyaquic Paleustalfs

Geomorphic position: summits and sideslopes of low hills and ridges

Parent material: residuum weathered from calcareous sandstone and/or residuum weathered from cherty limestone

Slope: 2 to 15 percent

Surface fragments: about 25 percent gravel

Depth to restrictive feature: 40 to 60 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.03 in/hr (very slow)

Available water capacity total inches: 6.4

Shrink-swell potential: about 7.0 LEP (high)

Flooding hazard: None

Seasonal water table minimum depth: Saturated with water in one or more layers within 40 inches in normal years 20 or more consecutive days or 30 or more cumulative days

Runoff class: Medium

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-9

Ecological site name: Loamy Hills, Cold (ABLA, PIEN) 25-33" p.z.

Ecosystem site number: 035XI903AZ

Present native vegetation: Engelmann spruce, quaking aspen, subalpine fir, Douglas-fir, other coniferous trees

Land capability (nonirrigated): 5c

Taxonomic Unit Description

Type Location: On the Kaibab Plateau; 1,278 feet northeast of Hades Lake; 36 degrees, 15 minutes, 34 seconds north latitude; 112 degrees, 4 minutes, 41 seconds west longitude.

Oi—0 to 1 inch; slightly decomposed mixed conifer and aspen litter.

Oe—1 to 2 inches; black (10YR 2/1) moderately decomposed mixed conifer and aspen litter.

A1—2 to 4 inches; pale brown (10YR 6/3) gravelly loam, dark yellowish brown (10YR 4/4) moist; weak medium platy structure parting to weak fine subangular blocky; slightly hard, very friable, nonsticky and slightly plastic; many very fine and common fine roots; few very fine and fine tubular pores; 15 percent gravel; noneffervescent; strongly acid (pH 5.4); abrupt wavy boundary.

A2—4 to 7 inches; pale brown (10YR 6/3) gravelly loam, dark yellowish brown (10YR 4/4) moist; weak fine subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; many very fine and common fine and medium roots; few very fine and fine tubular pores; 20 percent gravel, 2 percent cobbles; noneffervescent; strongly acid (pH 5.3); clear wavy boundary.

AE—7 to 12 inches; light brown (7.5YR 6/3) very gravelly loam, brown (7.5YR 4/4) moist; weak fine subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; common very fine and fine, and few medium and coarse roots; few very fine and fine tubular pores; 35 percent gravel, 5 percent cobbles; noneffervescent; moderately acid (pH 5.8); clear wavy boundary.

E—12 to 20 inches; pink (7.5YR 7/3) very gravelly loam, brown (7.5YR 4/3) moist; weak very fine and fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine, and few medium and coarse roots; common very fine and few fine tubular pores; 45 percent gravel, 5 percent

cobbles; noneffervescent; slightly acid (pH 6.2); abrupt wavy boundary.

Bt1—20 to 39 inches; strong brown (7.5YR 5/6) clay, strong brown (7.5YR 5/6) moist; strong coarse angular blocky structure; very hard, very firm, sticky and very plastic; few very fine roots oriented along faces of peds; few very fine tubular pores; many distinct clay films on faces of peds; 5 percent gravel; noneffervescent; strongly acid (pH 5.4); gradual smooth boundary.

Bt2—39 to 50 inches; variegated yellowish red (5YR 4/6) and red (2.5YR 4/6) gravelly clay, variegated yellowish red (5YR 4/6) and red (2.5YR 4/6) moist; strong coarse angular blocky structure; very hard, very firm, sticky and very plastic; few very fine roots oriented along faces of peds; few very fine tubular pores; many distinct clay films on faces of peds; 15 percent gravel, 2 percent cobbles; noneffervescent; very strongly acid (pH 4.8); abrupt wavy boundary.

R/Cr—50 inches; fractured, very slightly to slightly weathered cherty fine-grained sandstone bedrock with irregular pockets of increasingly weathered cherty sandstone.

Range in Characteristics

Particle size control section (weighted average): clay content—65 to 75 percent; Rock fragments—5 to less than 35 percent

Depth to bedrock: 40 to 60 inches

Depth to argillic: 14 to 40 inches

A horizon(s)

Hue: 7.5YR, 10YR

Value: 3 through 6 dry, 3 through 5 moist

Chroma: 2 through 4, dry or moist

Reaction: strongly acid to neutral

E horizon

Hue: 7.5YR, 10YR

Value: 5 through 7 dry, 4 through 6 moist

Chroma: 3 dry, 3 or 4 moist

Clay content: 8 to 15 percent

Rock fragments: 20 to 70 percent

Reaction: strongly acid to neutral

Bt horizon(s)

Hue: 2.5YR, 5YR, 7.5YR

Value: 3 through 6 dry, 3 through 5 moist

Chroma: 4 through 6, dry or moist

Reaction: very strongly acid to slightly acid

Some pedons have Bt/E or E/Bt horizons.

54—Kanackey family, 8 to 15 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,500 to 4,500 feet (1,067 to 1,372 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 200 to 240 days

Map Unit Composition

Kanackey family and similar soils: 90 percent

Minor components: 10 percent

- Soils that have petrocalcic horizons
- Soils in drainageways that are occasionally flooded
- Soils that are deeper than 20 inches to bedrock
- Soils that have no accumulation of calcium carbonate in the profile
- Talus slopes devoid of vegetation

Properties and Qualities

Kanackey family soils

Taxonomic classification: Clayey-skeletal, smectitic, thermic Lithic Haplargids

Geomorphic position: pediments of the Shinumu Quartzite

Parent material: residuum weathered from orthoquartzite

Slope: 8 to 15 percent

Surface fragments: about 15 percent cobbles, about 15 percent gravel, about 5 percent stones

Depth to restrictive feature: 8 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.13 in/hr (slow)

Available water capacity total inches: 1.2

Shrink-swell potential: about 5.0 LEP (moderate)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: High

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Upland, Shallow 6-10" p.z.

Ecosystem site number: 035XE519AZ

Present native vegetation: blackbrush, ephedra, Opuntia, banana yucca

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Tonto Platform; 843 feet east of The Tipoff; 36 degrees, 5 minutes, 31 seconds north latitude; 112 degrees, 5 minutes, 12 seconds west longitude.

A—0 to 2 inches; brown (7.5YR 5/4) very cobbly sandy loam; dark brown (7.5YR 3/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; common very fine and fine tubular pores; 20 percent gravel, 20 percent cobble, and 2 percent stone; noneffervescent; neutral (pH 7.0); abrupt smooth boundary.

Bt1—2 to 7 inches; reddish brown (5YR 4/4) very gravelly sandy clay loam; dark reddish brown (5YR 3/4) moist; moderate fine and medium subangular blocky structure; slightly hard, very friable, moderately sticky and moderately plastic; common very fine and fine and few medium roots; common very fine and fine tubular pores; few faint clay films on faces of peds and lining pores; 40 percent gravel, 5 percent cobble; noneffervescent; neutral (pH 7.0); clear smooth boundary.

Bt2—7 to 12 inches; yellowish red (5YR 4/6) very gravelly sandy clay; dark reddish brown (5YR 3/4) moist; strong fine and medium subangular blocky structure; hard, friable, very sticky and very plastic; few very fine and fine roots; few fine tubular pores; common distinct clay films on faces of peds and lining pores; 40 percent gravel, 5 percent cobble; slightly effervescent; slightly alkaline (pH 7.8); clear smooth boundary.

Bt3—12 to 15 inches; yellowish red (5YR 4/6) very gravelly clay loam; dark reddish brown (5YR 3/4) moist; weak medium subangular blocky structure; hard, friable, very sticky and very plastic; few very fine and fine roots; few fine tubular pores; few faint clay films lining pores; 40 percent gravel, 5 percent cobble; strongly effervescent; slightly alkaline (pH 7.8); abrupt irregular boundary.

R—15 inches; quartzite bedrock.

Range in Characteristics

Rock fragments: 20 to 30 percent gravel, and 10 to 30 percent cobble

Reaction: neutral to moderately alkaline

Clay content: averages 35 to 45 percent in the particle size control section

Organic matter: less than 1 percent

A horizon

Hue: 7.5YR, 10YR

Value: 3, 4 or 5, dry or moist

Effervescence: noneffervescent to strong

Bt horizons

Hue: 5YR, 7.5YR, 10YR

Value: 4 through 6, dry or moist

Chroma: 3 through 6, dry or moist

Effervescence: noneffervescent to strong

55—Kellypoint-Luzena complex, 2 to 15 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,800 to 6,600 feet (1,767 to 2,011 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)

Mean annual soil temperature: 50 to 54 degrees F (11 to 13 degrees C)

Frost-free period: 135 to 150 days

Map Unit Composition

Kellypoint and similar soils: 65 percent

Luzena and similar soils: 15 percent

Minor components: 20 percent

- Rock outcrop
- Rockyroad very cobbly silty clay loam soils
- Albers silty clay loam
- Soils in drainageways that are subject to occasional flooding
- Soils more than 40 inches deep to bedrock
- Soils that have a stony or very stony surface phase

Properties and Qualities

Kellypoint soils

Taxonomic classification: Fine, smectitic, mesic Vertic Argiustolls

Geomorphic position: summits and concavities on basalt flows

Parent material: residuum weathered from basalt

Slope: 2 to 15 percent

Surface fragments: about 20 percent coarse gravel, about 25 percent cobbles, about 10 percent stones

Depth to restrictive feature: 24 to 32 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.01 in/hr (very slow)
Available water capacity total inches: 3.5
Shrink-swell potential: about 10.0 LEP (very high)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: Medium
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-6
Ecological site name: Clay Loam Upland, Gravelly (PIED, JUOS) 13-17" p.z.
Ecosystem site number: 035XF611AZ
Present native vegetation: muttongrass, Utah juniper, Wyoming big sagebrush, blue grama, Colorado pinyon
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Shivwits Plateau; 4,412 feet northeast of Deer Flat Tank, 35 degrees, 57 minutes, 15 seconds north latitude; 113 degrees, 28 minutes, 19 seconds west longitude.

A—0 to 2 inches; dark brown (7.5YR 3/2) very cobbly silty clay loam; very dark brown (7.5YR 2.5/2) moist; strong very fine granular structure; soft, very friable, moderately sticky and moderately plastic; few very fine roots; many very fine and fine irregular pores; noneffervescent; 20 percent gravel, 25 percent cobble, 10 percent stone; neutral (pH 6.8); abrupt smooth boundary.

Bt—2 to 5 inches; dark brown (7.5YR 3/2) stony silty clay loam; very dark brown (7.5YR 2.5/3) moist; strong medium subangular blocky structure; hard, friable, very sticky and very plastic; common very fine through coarse roots; common very fine and fine and few medium and coarse tubular pores; few faint clay films on faces of peds; noneffervescent; 5 percent gravel, 5 percent cobble, 5 percent stone; neutral (pH 6.8); clear wavy boundary.

Btss1—5 to 14 inches; dark brown (7.5YR 3/3) clay; very dark brown (7.5YR 2.5/3) moist; strong medium prismatic structure parting to strong medium angular blocky; very hard, firm, very sticky and very plastic; common fine through coarse roots surrounding peds; few fine tubular pores; many intersecting slickensides; many faint clay films on faces of peds; 5 percent gravel, 5 percent cobble; noneffervescent; neutral (pH 6.8); clear wavy boundary.

Btss2—14 to 28 inches; dark brown (7.5YR 3/2) cobbly clay; very dark brown (7.5YR 2.5/3) moist; strong coarse prismatic structure parting to strong medium

and coarse angular blocky; very hard, firm, very sticky and very plastic; few fine and medium roots surrounding peds; few fine tubular pores; many intersecting slickensides; many faint clay films on faces of peds; noneffervescent; 5 percent gravel, 15 percent cobble; neutral (pH 6.8); abrupt irregular boundary.

R—28 inches; fractured basalt bedrock.

Range in Characteristics

Depth to bedrock: 24 to 32 inches
 Depth to argillic horizon: 1 to 3 inches
 Rock fragments: average 10 to 20 percent in the particle size control section

A horizon

Hue: 7.5YR, 10YR
 Value: 3 or 4 dry, 2.5 or 3 moist
 Chroma: 2 or 3, dry or moist
 Organic matter: 2 through 4 percent

Bt horizons

Value: 3 or 4 dry, 2.5 or 3 moist
 Chroma: 2 or 3, dry or moist
 Clay content: 35 to 45 percent
 Texture: silty clay loam, clay
 Organic matter: 1 to 2 percent

Btss horizons

Hue: 5YR, 7.5YR
 Value: 3 or 4 dry, 2.5 or 3 moist
 Chroma: 2 or 3, dry or moist
 Clay content: 50 to 60 percent

Properties and Qualities

Luzena soils

Taxonomic classification: Clayey, smectitic, mesic Lithic Argiustolls
Geomorphic position: ridges and escarpments of basalt flows
Parent material: colluvium and/or residuum weathered from basalt
Slope: 2 to 15 percent
Surface fragments: about 30 percent coarse gravel, about 25 percent cobbles, about 5 percent boulders, about 10 percent stones
Depth to restrictive feature: 7 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Permeability: about 0.13 in/hr (slow)
Available water capacity total inches: 2.3
Shrink-swell potential: about 10.0 LEP (very high)
Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Medium

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Basalt Upland (JUOS) 13-17" p.z.

Ecosystem site number: 035XF620AZ

Present native vegetation: Utah juniper, muttongrass, Colorado pinyon, Stansbury cliffrose, bottlebrush squirreltail, turbinella oak

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Shivwits Plateau; 1.13 miles southwest of Deer Flat Tank, 35 degrees, 57 minutes, 2 seconds north latitude; 113 degrees, 30 minutes, 28 seconds west longitude.

A—0 to 1 inch; dark brown (7.5YR 3/3) very cobbly silty clay loam; very dark brown (7.5YR 2.5/3) moist; moderate very fine and fine granular structure; soft, very friable, very sticky and moderately plastic; few very fine and fine roots; many very fine irregular pores; 20 percent gravel, 25 percent cobble, 5 percent stone; noneffervescent; neutral (pH 7.0); abrupt smooth boundary.

Bt1—1 to 3 inches; dark brown (7.5YR 3/3) cobbly silty clay loam; very dark brown (7.5YR 2.5/3) moist; strong medium subangular blocky structure parting to strong very fine granular; hard, friable, very sticky and very plastic; many very fine and common fine roots; 5 percent gravel, 10 percent cobble; many very fine irregular and few fine tubular pores; common faint clay films on faces of peds and lining pores; noneffervescent; neutral (pH 7.0); abrupt wavy boundary.

Bt2—3 to 8 inches; brown (7.5YR 4/3) clay; dark brown (7.5YR 3/2) moist; strong coarse subangular blocky structure parting to strong medium and fine subangular blocky; very hard, firm, very sticky and very plastic; few very fine and medium and common fine roots; few fine tubular pores; 5 percent gravel; common faint clay films on faces of peds; noneffervescent; neutral (pH 6.8); clear smooth boundary;

Bt3—8 to 19 inches; brown (7.5YR 4/3) clay; dark brown (7.5YR 3/3) moist; strong coarse prismatic

structure parting to weak medium and coarse subangular blocky; very hard, very firm, very sticky and very plastic; common medium and few fine roots; few very fine and fine tubular pores; 5 percent gravel; common faint clay films on faces of peds; noneffervescent; neutral (pH 6.8); abrupt irregular boundary.

R—19 inches; basalt bedrock.

Range in Characteristics

Parent material: alluvium and colluvium from basalt

Depth to bedrock: 7 to 20 inches

Clay content: averages 35 to 59 percent in the particle size control section

Rock fragments: 5 to 35 percent in the particle size control section

A horizon

Hue: 5YR, 7.5YR, 10YR

Value: 3 through 5 dry, 2.5 or 3 moist

Chroma: 2 or 3, dry or moist

Organic matter: 2 or 3 percent

Bt horizons

Hue: 5YR, 7.5YR

Value: 3 through 5 dry, 2.5 or 3 moist

Chroma: 2 or 3, dry or moist

Texture: clay, clay loam, silty clay loam

Organic matter: 1 to 2, dry or q

Minor components: 15 percent

- Soils that are shallow or moderately deep to basalt bedrock
- Soils in drainageways that are subject to occasional flooding

Properties and Qualities

Kellypoint soils

Taxonomic classification: Fine, smectitic, mesic Vertic Paleustolls

Geomorphic position: summits and side slopes of hills and ridges on basalt flows

Parent material: colluvium and/or residuum weathered from basalt

Slope: 15 to 35 percent

Surface fragments: about 25 percent cobbles, about 20 percent coarse gravel

Depth to restrictive feature: 40 to 60 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.01 in/hr (very slow)

Available water capacity total inches: 6.3

Shrink-swell potential: about 10.0 LEP (very high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Basalt Slopes (JUOS, PIED) 13-17" p.z.

Ecosystem site number: 035XF624AZ

Present native vegetation: Utah juniper, needleandthread, Colorado pinyon, Stansbury cliffrose, galleta, Wyoming big sagebrush

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Shivwits Plateau, 342 feet west of Mount Dellenbaugh; 36 degrees, 6 minutes, 30 seconds north latitude; 113 degrees, 32 minutes, 30 seconds west longitude.

A—0 to 2 inches; dark brown (7.5YR 3/2) very cobbly loam; very dark brown (7.5YR 2.5/2) moist; weak fine subangular blocky structure parting to moderate fine and medium granular; soft, very friable, nonsticky and nonplastic; many very fine and fine and common medium roots; many very fine and fine irregular and tubular pores; very hydrophobic; 25 percent gravel, 25 percent cobble; noneffervescent; neutral (pH 6.8); abrupt smooth boundary.

Bt1—2 to 9 inches; dark reddish gray (5YR 4/2) cobbly silty clay; dark reddish brown (5YR 2.5/2) moist; strong fine and medium subangular blocky structure; hard, friable, very sticky and very plastic; common very fine through medium and few coarse roots; many very fine and fine and common medium and coarse tubular pores; 5 percent gravel, 25 percent cobble; many faint clay films on faces of peds; noneffervescent; neutral (pH 6.8); clear wavy boundary.

Bt2—9 to 17 inches; dark reddish gray (5YR 4/2) cobbly clay; dark reddish brown (5YR 2.5/2) moist; strong fine and medium angular blocky structure; very hard, firm, very sticky and very plastic; common fine and medium and few coarse roots; common fine through coarse tubular pores; 10 percent gravel, 10 percent cobble; many faint clay films on faces of peds; noneffervescent; neutral (pH 6.8); clear wavy boundary.

Btss—17 to 30 inches; reddish brown (5YR 5/4) clay; dark reddish brown (5YR 3/3) moist; strong fine and medium angular blocky structure; very hard, firm, very sticky and very plastic; few fine through coarse roots; few medium and coarse tubular pores; many faint clay films on faces of peds; common slickensides; noneffervescent; neutral (pH 6.8); gradual wavy boundary.

CB—30 to 39 inches; light reddish brown (2.5YR 6/4) clay loam; reddish brown (2.5YR 4/3) moist; massive; hard, friable, moderately sticky and moderately plastic; few fine through coarse roots; few medium and coarse tubular pores; few patchy and common faint clay films on faces of peds; noneffervescent; neutral (pH 6.8).

R—39 inches; vesicular basalt bedrock.

Range in Characteristics

This soil is a taxadjunct to the series. This soil lacks the vertic soil features as required by the series.

Depth to bedrock: 40 to 60 inches

Clay content: averages 40 to 55 percent in the particle size control section

A horizon

Hue: 7.5YR, 10YR

Value: 3 or 4 dry, 2.5 or 3 moist

Chroma: 2 or 3, dry or moist

Bt horizons

Hue: 5YR, 7.5YR

Value: 4 through 6 dry; 2.5 or 3 moist

Chroma: 2 through 4 dry; 2 or 3 moist

Reaction: slightly acid to neutral

Calcium carbonate equivalent: less than 5 percent

Texture: silty clay, clay
 Rock fragments: 15 to 35 percent

C/B horizon

May not be present in all pedons.

Rock outcrop

Ridges and escarpments of basalt flows

57—Lava Flows-Typic Torriorthents complex, 30 to 60 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 1,600 to 2,500 feet (488 to 762 meters)

Mean annual precipitation: 6 to 9 inches (152 to 229 millimeters)

Mean annual air temperature: 64 to 70 degrees F (18 to 21 degrees C)

Mean annual soil temperature: 66 to 72 degrees F (20 to 23 degrees C)

Frost-free period: 180 to 200 days

Map Unit Composition

Lava Flows: 80 percent

Typic Torriorthents and similar soils: 20 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Lava Flows

Very steep lava flows on escarpments and canyon walls

Typic Torriorthents soils

Taxonomic classification: Typic Torriorthents

Geomorphic position: pockets and ledges of very steep basalt flows

Parent material: alluvium derived from basalt and/or colluvium derived from basalt

Slope: 30 to 60 percent

Depth to restrictive feature: 10 to 60 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 30

Land Resource Unit: 30-2

Ecological site name: Basalt Slopes 6-9" p.z.

Ecosystem site number: 030XB203AZ

Present native vegetation: white bursage, big galleta, creosotebush, Nevada Mormon tea, white ratany

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In the Grand Canyon interior, about 2,000 feet north of Whitmore Rapids, 36 degrees, 9 minutes, 12 seconds north latitude; 113 degrees, 12 minutes, 4 seconds west longitude.

A—0 to 2 inches; pale brown (10YR 6/3) extremely stony coarse sandy loam; brown (10YR 4/3) moist; strong thin platy structure; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine and fine irregular pores; 5 percent gravel, 10 percent cobble, and 70 percent stone; strongly effervescent; moderately alkaline (pH 8.0); abrupt irregular boundary.

Bw1—2 to 35 inches; pale brown (10YR 6/3) extremely stony fine sandy loam; dark yellowish brown (10YR 4/4) moist; weak fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and few medium and coarse roots; few fine tubular pores; 10 percent gravel, 15 percent cobble, and 60 percent stone; violently effervescent; moderately alkaline (pH 8.2); gradual irregular boundary.

Bw2—35 to 60 inches; pale brown (10YR 6/3) extremely stony loam; dark yellowish brown (10YR 4/4) moist; weak fine and medium subangular blocky structure; soft, friable, slightly sticky and slightly plastic; few fine through coarse roots; few fine tubular pores; 5 percent gravel, 20 percent cobble, and 60 percent stone; violently effervescent; moderately alkaline (pH 8.2).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

58—Lithic Haplargids, Shinumo Formation, 8 to 15 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,500 to 4,500 feet (1,067 to 1,372 meters)
Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)
Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)
Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)
Frost-free period: 200 to 240 days

Map Unit Composition

Lithic Haplargids and similar soils: 100 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Lithic Haplargids soils

Taxonomic classification: Lithic Haplargids
Geomorphic position: pediments
Parent material: residuum weathered from quartzite
Slope: 8 to 15 percent
Depth to restrictive feature: 8 to 20 inches to bedrock (lithic)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Major Land Resource Area: 35
Land Resource Unit: 35-5
Ecological site name: Limy Upland, Shallow 6-10" p.z.
Ecosystem site number: 035XE519AZ
Present native vegetation: blackbrush, ephedra, Opuntia, banana yucca
Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Tonto Platform; 843 feet east of The Tipoff; 36 degrees, 5 minutes, 31 seconds north latitude; 112 degrees, 5 minutes, 12 seconds west longitude.

A—0 to 2 inches; brown (7.5YR 5/4) very cobbly sandy loam; dark brown (7.5YR 3/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; common very fine and fine tubular pores; 20 percent gravel, 20 percent cobble, and 2 percent stone; noneffervescent; neutral (pH 7.0); abrupt smooth boundary.

Bt1—2 to 7 inches; reddish brown (5YR 4/4) very gravelly sandy clay loam; dark reddish brown (5YR 3/4) moist; moderate fine and medium subangular blocky

structure; slightly hard, very friable, moderately sticky and moderately plastic; common very fine and fine and few medium roots; common very fine and fine tubular pores; few faint clay films on faces of peds and lining pores; 40 percent gravel, 5 percent cobble; noneffervescent; neutral (pH 7.0); clear smooth boundary.

Bt2—7 to 12 inches; yellowish red (5YR 4/6) very gravelly sandy clay; dark reddish brown (5YR 3/4) moist; strong fine and medium subangular blocky structure; hard, friable, very sticky and very plastic; few very fine and fine roots; few fine tubular pores; common distinct clay films on faces of peds and lining pores; 40 percent gravel, 5 percent cobble; slightly effervescent; slightly alkaline (pH 7.8); clear smooth boundary.

Bt3—12 to 15 inches; yellowish red (5YR 4/6) very gravelly clay loam; dark reddish brown (5YR 3/4) moist; weak medium subangular blocky structure; hard, friable, very sticky and very plastic; few very fine and fine roots; few fine tubular pores; few faint clay films lining pores; 40 percent gravel, 5 percent cobble; strongly effervescent; slightly alkaline (pH 7.8); abrupt irregular boundary.

R—15 inches; quartzite bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

59—Lithic Haplargids-Rock outcrop complex, Redwall Formation, 2 to 30 percent slopes

Map Unit Setting

Landform: plateau
Elevation: 3,500 to 4,500 feet (1,067 to 1,372 meters)
Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)
Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)
Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)
Frost-free period: 200 to 240 days

Map Unit Composition

Lithic Haplargids and similar soils: 80 percent
Rock outcrop: 20 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Lithic Haplargids soils

Taxonomic classification: Lithic Haplargids

Geomorphic position: summits and sideslopes of low hills

Parent material: residuum weathered from limestone

Slope: 2 to 30 percent

Depth to restrictive feature: 10 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Upland, Shallow 6-10" p.z.

Ecosystem site number: 035XE519AZ

Present native vegetation: blackbrush, ephedra, Opuntia, banana yucca

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 36 degrees, 23 minutes, 33 seconds north latitude; 111 degrees, 50 minutes, 41 seconds west longitude.

A—0 to 2 inches; brown (7.5YR 5/4) very gravelly fine sandy loam; brown (7.5YR 4/4) moist; moderate thin platy structure parting to moderate very fine subangular blocky; soft, very friable, nonsticky and nonplastic; many very fine and few fine roots; common very fine vesicular pores; 25 percent gravel, 5 percent cobble, and 5 percent stone; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bt—2 to 6 inches; reddish brown (5YR 5/4) very gravelly sandy clay loam; reddish brown (5YR 4/4) moist; moderate very fine and fine subangular blocky structure; slightly hard, friable, moderately sticky and moderately plastic; common very fine and few fine roots; common very fine tubular pores; common faint clay films on faces of peds and lining pores; 25 percent gravel, 10 percent cobble, and 5 percent stone;

violently effervescent; moderately alkaline (pH 8.4); abrupt wavy boundary.

Btk—6 to 11 inches; reddish brown (2.5YR 5/4) extremely channery clay loam; reddish brown (2.5YR 4/4) moist; moderate very fine and fine subangular blocky structure; slightly hard, friable, moderately sticky and moderately plastic; common very fine roots; common very fine tubular pores; common faint clay films on faces of peds and lining pores; few very fine soft seams and filaments of calcium carbonate; 25 percent gravel, 30 percent slightly weathered and slightly displaced channers and 5 percent slightly weathered and slightly displaced flagstone; violently effervescent; moderately alkaline (pH 8.4); abrupt wavy boundary.

R—11 inches; limestone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Rock outcrop

Escarments of the Redwall Formation

60—Lithic Haplargids-Typic Haplargids-Lava Flows complex, 2 to 35 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,600 to 4,500 feet (1,097 to 1,372 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 210 to 280 days

Map Unit Composition

Lithic Haplargids and similar soils: 50 percent
Typic Haplargids and similar soils: 35 percent
Lava Flows: 15 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Lithic Haplargids soils

Taxonomic classification: Lithic Haplargids

Geomorphic position: summits and side slopes of ridges of basalt

Parent material: residuum weathered from basalt

Slope: 4 to 35 percent

Depth to restrictive feature: 14 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Basalt Hills 6-10" p.z.

Ecosystem site number: 035XE501AZ

Present native vegetation: ephedra, catclaw acacia, blue threeawn, rayless brittlebush, Ferocactus

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In Whitmore Canyon; 1.39 miles southwest of Webbs Ranch Landing Strip; 36 degrees, 14 minutes, 23 seconds north latitude; 113 degrees, 14 minutes, 31 seconds west longitude.

A—0 to 1 inch; yellowish brown (10YR 5/4) extremely gravelly loam; dark yellowish brown (10YR 3/4) moist; weak medium platy structure parting to moderate medium granular; soft, very friable, slightly sticky and slightly plastic; many very fine roots; common very fine irregular and vesicular and few fine tubular pores; noneffervescent, 55 percent gravel, 15 percent cobble, 5 percent stone; slightly alkaline (pH 7.6); abrupt smooth boundary.

Bt—1 to 4 inches; brown (7.5YR 5/4) very gravelly loam; dark brown (7.5YR 3/4) moist; weak medium platy structure parting to moderate fine and medium subangular blocky; slightly hard, very friable, moderately sticky and moderately plastic; few very fine and fine roots; common very fine and fine tubular pores; many faint clay films on faces of peds and many distinct clay films lining pores; noneffervescent; 30 percent gravel, 10 percent cobble; slightly alkaline (pH 7.6); abrupt wavy boundary.

Btk1—4 to 10 inches; brown (7.5YR 4/4) gravelly clay loam; dark brown (7.5YR 3/4) moist; moderate medium

subangular blocky structure; slightly hard, very friable, moderately sticky and moderately plastic; common very fine through medium roots; common very fine through medium tubular pores; many faint to distinct clay films on faces of peds and lining pores; few thin calcium carbonate coats on the undersides of coarse fragments; slightly effervescent; 30 percent gravel, 10 percent cobble; moderately alkaline (pH 8.0); clear wavy boundary.

Btk2—10 to 19 inches; brown (7.5YR 4/4) very cobbly clay loam; dark brown (7.5YR 3/4) moist; moderate medium and coarse subangular blocky structure; slightly hard, very friable, moderately sticky and moderately plastic; common very fine roots as masses adjacent to peds; common very fine and fine tubular pores; common faint and distinct clay films on faces of peds and lining pores; few fine soft filaments and common fine seams of calcium carbonate, common thin calcium carbonate coats on the undersides of coarse fragments; violently effervescent; 20 percent gravel, 30 percent cobble; moderately alkaline (pH 8.2); abrupt irregular boundary.

R—19 inches; basalt bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Typic Haplargids soils

Taxonomic classification: Typic Haplargids

Geomorphic position: depressions between ridges of basalt

Parent material: residuum weathered from basalt

Slope: 2 to 6 percent

Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Clay Loam Upland 6-10" p.z.

Ecosystem site number: 035XE520AZ

Present native vegetation: galleta, Nevada Mormon tea, black grama, Mexican bladdersage, bush muhly

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In Whitmore Canyon; 3,774 feet west of Paws Pocket; 36 degrees, 13 minutes, 3 seconds north latitude; 113 degrees, 13 minutes, 45 seconds west longitude.

A1—0 to 1 inch; yellowish brown (10YR 5/4) cobbly loam; dark yellowish brown (10YR 3/4) moist; weak fine subangular blocky and platy structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; common very fine and few fine irregular pores; noneffervescent; 10 percent gravel, 10 percent cobble, and 5 percent stone; slightly alkaline (pH 7.8); abrupt smooth boundary.

A2—1 to 3 inches; yellowish brown (10YR 5/4) very cobbly silt loam; dark yellowish brown (10YR 3/4) moist; weak fine subangular blocky and strong very thin platy structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; many very fine and few fine irregular pores; noneffervescent; 15 percent gravel, 10 percent cobble, and 10 percent stone; moderately alkaline (pH 8.0); abrupt wavy boundary.

Bt—3 to 8 inches; yellowish brown (10YR 5/4) very cobbly silt loam; dark yellowish brown (10YR 3/4); moderate medium subangular blocky structure; slightly hard, very friable, moderately sticky and moderately plastic; common very fine and few fine roots; common very fine irregular and few fine tubular pores; common red (2.5YR 4/6) stains on faces of peds; lower part has discontinuous (less than 10 percent) moderate medium subangular blocky peds, brown (7.5YR 5/4) silty clay loam with common faint clay films on faces of peds and lining pores; noneffervescent; 15 percent gravel, 15 percent cobble, and 10 percent stone; moderately alkaline (pH 8.0); clear wavy boundary.

Btk—8 to 19 inches; brown (7.5YR 5/4) very stony silty clay loam; dark brown (7.5YR 3/4) moist; moderate and strong medium subangular blocky structure; hard, friable, moderately sticky and moderately plastic; common very fine and few fine and medium roots; common very fine and fine and few medium and coarse tubular pores; common thin clay films on faces of peds and lining pores; common fine filaments and soft masses and few medium soft masses of calcium carbonate; slightly effervescent; 10 percent gravel, 15 percent cobble, and 20 percent stone; moderately alkaline (pH 8.2); clear wavy boundary.

Bk—19 to 25 inches; brown (7.5YR 5/4) very gravelly silty clay loam; brown (7.5YR 4/4) moist; massive; hard, firm, moderately sticky and moderately plastic;

few very fine roots; common very fine and fine tubular pores; very few fine seams and soft masses of calcium carbonate; slightly effervescent; 25 percent gravel, 10 percent cobble, and 10 percent stone; moderately alkaline (pH 8.4); abrupt irregular boundary.

R—25 inches; basalt bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Lava Flows

Pressure ridges and push ups of basalt flows

61—Lithic Haplocalcids, Pakoon Limestone, 2 to 8 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,500 to 5,000 feet (1,372 to 1,524 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 55 to 57 degrees F (13 to 14 degrees C)

Mean annual soil temperature: 57 to 59 degrees F (15 to 16 degrees C)

Frost-free period: 180 to 195 days

Map Unit Composition

Lithic Haplocalcids and similar soils: 100 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Lithic Haplocalcids soils

Taxonomic classification: Lithic Haplocalcids

Geomorphic position: summits

Parent material: residuum weathered from limestone and sandstone

Slope: 2 to 8 percent

Depth to restrictive feature: 9 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Upland, Shallow 6-10" p.z.

Ecosystem site number: 035XE519AZ

Present native vegetation: blackbrush, ephedra, Opuntia, banana yucca

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Sanup Plateau; 2.91 miles west of Snap Point; 36 degrees, 9 minutes, 47 seconds north latitude; 113 degrees, 51 minutes, 1 second west longitude.

A—0 to 2 inches; yellowish brown (10YR 5/4) very stony loam; dark yellowish brown (10YR 4/4) moist; weak thick platy structure; soft, very friable, slightly sticky and moderately plastic; common very fine and few fine roots; many very fine and fine irregular and few fine tubular pores; 25 percent gravel, 10 percent cobble, and 10 percent stone; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bk1—2 to 7 inches; yellowish brown (10YR 5/4) loam; dark yellowish brown (10YR 4/4) moist; moderate fine and medium subangular blocky structure; soft, very friable, slightly sticky and moderately plastic; common very fine and fine and few medium roots; common very fine and fine irregular and few fine tubular pores; 10 percent gravel; 15 percent calcium carbonate occurring as filaments; 5 percent calcium carbonate occurring as soft masses; thick calcium carbonate coatings on the undersides of rock fragments; violently effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

Bk2—7 to 14 inches; light brown (7.5YR 6/4) gravelly sandy loam; brown (7.5YR 5/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common fine and few medium roots; few very fine and fine irregular and few fine tubular pores; 15 percent gravel, 5 percent cobble; 35 percent calcium carbonate occurring as soft masses and concretions; violently effervescent; strongly alkaline (pH 8.6); abrupt wavy boundary.

R—14 inches; hard limestone bedrock

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access,

statistically valid data could not be determined.

Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

62—Lithic Haplocalcids-Rock outcrop complex, Esplanade Formation, 2 to 15 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,000 to 4,300 feet (1,219 to 1,311 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 55 to 57 degrees F (13 to 14 degrees C)

Mean annual soil temperature: 57 to 59 degrees F (15 to 16 degrees C)

Frost-free period: 180 to 195 days

Map Unit Composition

Lithic Haplocalcids and similar soils: 70 percent
Rock outcrop: 30 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Lithic Haplocalcids soils

Taxonomic classification: Lithic Haplocalcids

Geomorphic position: Concavities and pockets

Parent material: colluvium derived from calcareous sandstone and/or eolian deposits derived from mixed and/or residuum weathered from calcareous sandstone

Slope: 2 to 15 percent

Depth to restrictive feature: 14 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Upland, Shallow 6-10" p.z.

Ecosystem site number: 035XE519AZ

Present native vegetation: blackbrush, ephedra, Opuntia, banana yucca

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Esplanade; 4,034 feet southwest of Mollies Nipple; 36 degrees, 5 minutes, 17 seconds north latitude; 113 degrees, 22 minutes, 33 seconds west longitude.

A—0 to 2 inches; yellowish red (5YR 4/6) fine sandy loam; dark reddish brown (5YR 3/4) moist; strong thin platy structure parting to moderate fine subangular blocky; slightly hard, very friable, nonsticky and slightly plastic; few very fine roots; common very fine and fine irregular pores; slightly effervescent; 10 percent channers; moderately alkaline (pH 8.4); abrupt wavy boundary.

Bk1—2 to 8 inches; yellowish red (5YR 5/6) fine sandy loam; dark red (2.5YR 3/6) moist; weak coarse subangular blocky structure parting to moderate medium angular blocky; hard, friable, slightly sticky and slightly plastic; common very fine and few fine and medium roots; common very fine through coarse tubular pores; common fine and few medium seams and soft masses and common fine filaments of calcium carbonate; violently effervescent; 10 percent channers; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bk2—8 to 11 inches; yellowish red (5YR 5/6) channery fine sandy loam; dark red (2.5YR 3/6) moist; moderate fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and few fine and medium roots; common very fine through coarse tubular pores; common fine and medium seams and common fine soft masses and filaments of calcium carbonate; violently effervescent; 15 percent channers, 5 percent flagstone; moderately alkaline (pH 8.4); abrupt smooth boundary.

2Bk—11 to 16 inches; yellowish red (5YR 5/6) extremely flaggy fine sandy loam; red (2.5YR 4/6) moist; massive; soft, very friable, slightly sticky and slightly plastic; few fine roots; few very fine irregular pores; many fine and medium and few coarse seams and soft masses of calcium carbonate; violently effervescent; 30 percent channers, 50 percent flagstone; strongly alkaline (pH 8.6); abrupt smooth boundary.

2R—16 inches; hard Esplanade sandstone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical

properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Rock outcrop

Flat to slightly rolling pediments of calcareous sandstone of the Esplanade Formation

63—Lithic Haplocambids-Lithic Haplargids complex, Bright Angel and Tapeats Formations, 2 to 15 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,500 to 4,500 feet (1,067 to 1,372 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 200 to 240 days

Map Unit Composition

Lithic Haplocambids and similar soils: 60 percent

Lithic Haplargids and similar soils: 40 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Lithic Haplocambids soils

Taxonomic classification: Lithic Haplocambids

Geomorphic position: pediments

Parent material: residuum weathered from calcareous shale

Slope: 2 to 15 percent

Depth to restrictive feature: 12 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Upland, Shallow 6-10" p.z.

Ecosystem site number: 035XE519AZ

Present native vegetation: blackbrush, ephedra,
Opuntia, banana yucca

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Tonto Platform; 1,070 feet southwest of Plateau Point; 36 degrees, 5 minutes, 18 seconds north latitude; 112 degrees, 7 minutes, 37 seconds west longitude.

A—0 to 1 inch; yellowish brown (10YR 5/4) extremely channery loam; brown (10YR 4/3) moist; moderate medium platy structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine irregular, few fine interstitial and few fine tubular pores; 75 percent channers; very slightly effervescent; slightly alkaline (pH 7.8); abrupt smooth boundary.

Bw1—1 to 2 inches; brown (7.5YR 5/4) channery clay loam; brown (7.5YR 4/4) moist; weak medium platy structure parting to strong very fine and fine granular; slightly hard, very friable, moderately sticky and moderately plastic; few very fine roots; many very fine irregular pores; 20 percent channers; slightly effervescent; slightly alkaline (pH 7.8), abrupt smooth boundary.

Bw2—2 to 6 inches; brown (7.5YR 5/4) extremely channery loam; brown (7.5YR 4/4) moist; weak fine subangular blocky structure parting to moderate fine granular; slightly hard, very friable, moderately sticky and moderately plastic; common very fine and few fine roots; common very fine irregular, few very fine tubular and common very fine interstitial pores; 75 percent channers; strongly effervescent; slightly alkaline (pH 7.8); clear smooth boundary.

Bw3—6 to 17 inches; dark reddish brown (5YR 3/2) extremely channery loam; dark reddish brown (5YR 2.5/2) moist; weak thin platy structure parting to moderate fine subangular blocky; hard, friable, sticky and moderately plastic; few very fine and very few fine roots; many very fine irregular and common very fine and few fine tubular pores; 70 percent channers; slightly effervescent; slightly alkaline (pH 7.8); abrupt smooth boundary.

Cr—17 inches; highly fractured Bright Angel Shale occurring in horizontal plates 5 to 12 millimeters thick with vertical fractures spaced 75 to 125 millimeters apart. Roots penetrate vertical fractures at intervals of less than 125 millimeters.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Lithic Haplargids soils

Taxonomic classification: Lithic Haplargids

Geomorphic position: pediments

Parent material: residuum weathered from calcareous sandstone

Slope: 2 to 15 percent

Depth to restrictive feature: 6 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Upland, Shallow 6-10" p.z.

Ecosystem site number: 035XE519AZ

Present native vegetation: blackbrush, ephedra,
Opuntia, banana yucca

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Tonto Platform; 36 degrees, 5 minutes, 15 seconds north latitude; 112 degrees, 6 minutes, 9 seconds west longitude.

A—0 to 2 inches; brown (7.5YR 4/4) very gravelly loam; dark brown (7.5YR 3/4) moist; weak medium subangular blocky structure parting to moderate very fine subangular blocky; soft, very friable, moderately sticky and moderately plastic; few very fine roots; many very fine irregular and tubular pores; 35 percent gravel and 5 percent cobble; slightly effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bt—2 to 8 inches; yellowish red (5YR 4/6) very gravelly silty clay; yellowish red (5YR 4/6) moist; moderate fine subangular blocky structure; slightly hard, friable, very sticky and very plastic; common very fine through medium roots; common fine and medium tubular pores; few faint clay films lining pores; common thin calcium carbonate coats and pendants on rock fragments; 40 percent gravel, 5 percent cobble; slightly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Btk—8 to 10 inches; red (2.5YR 4/6) extremely gravelly silty clay loam; yellowish red (5YR 4/6) moist; strong fine subangular blocky structure; slightly hard, friable, moderately sticky and moderately plastic; common medium and few coarse roots; common fine and few medium tubular pores; common distinct clay films on faces of peds and lining pores; common medium soft masses of calcium carbonate; many moderately thick calcium carbonate coats and pendants on rock fragments; 60 percent gravel, 5 percent cobble; strongly effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

R—10 inches; Tapeats sandstone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

64—Lithic Haplustalfs-Lava Flows complex, 30 to 60 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,000 to 7,500 feet (1,524 to 2,286 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)

Mean annual soil temperature: 50 to 54 degrees F (11 to 13 degrees C)

Frost-free period: 135 to 150 days

Map Unit Composition

Lithic Haplustalfs and similar soils: 55 percent

Lava Flows: 45 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Lithic Haplustalfs soils

Taxonomic classification: Lithic Haplustalfs

Geomorphic position: pockets and ledges on steep basalt flows

Parent material: residuum weathered from basalt

Slope: 30 to 60 percent

Depth to restrictive feature: 7 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Basalt Slopes (JUOS, PIED) 13-17" p.z.

Ecosystem site number: 035XF624AZ

Present native vegetation: Utah juniper, needleandthread, Colorado pinyon, Stansbury cliffrose, galleta, Wyoming big sagebrush

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In the Uinkaret Mountains; 1.93 miles east of Mount Emma; 36 degrees, 15 minutes, 57 seconds north latitude; 113 degrees, 8 minutes, 11 seconds west longitude.

A—0 to 2 inches; pale brown (10YR 6/3) very gravelly loam; dark brown (10YR 3/3) moist; moderate thin platy structure parting to moderate very fine and fine subangular blocky; soft, very friable, slightly sticky and slightly plastic; common very fine roots; common very fine and few fine vesicular and common fine tubular pores; 25 percent gravel; 5 percent cobble, and 5 percent stone; noneffervescent; neutral (pH 7.2); abrupt smooth boundary.

Bt1—2 to 8 inches; brown (10YR 5/3) gravelly loam; dark brown (10YR 3/3) moist; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and moderately plastic; common very fine and few fine and medium roots; common very fine and few fine tubular pores; common faint clay films on faces of peds and lining pores; 20 percent gravel, 5 percent cobble; noneffervescent; neutral (pH 7.2); clear smooth boundary.

Bt2—8 to 14 inches; pale brown (10YR 6/3) very cobbly loam; brown (10YR 4/3) moist; moderate fine

subangular blocky structure; slightly hard, friable, slightly sticky and moderately plastic; few very fine through coarse roots; common very fine and few fine tubular pores; many faint clay films lining pores and few thin clay films on faces of peds; 20 percent gravel, 15 percent cobble; noneffervescent; neutral (pH 7.2); gradual smooth boundary.

Bt3—14 to 18 inches; light yellowish brown (10YR 6/4) very cobbly loam; dark yellowish brown (10YR 4/4) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and moderately plastic; few fine through coarse roots; common very fine and few fine tubular pores; common thin clay films lining pores and few faint clay films on faces of peds; 20 percent gravel, 20 percent cobble, and 5 percent stone; noneffervescent; neutral (pH 7.2); abrupt wavy boundary.

R—18 inches; fractured, slightly weathered basalt bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Lava Flows

Basalt flows on steep sides of cinder cones

65—Lithic Haplustolls-Udic Haplustolls-Rock outcrop complex, Kaibab, Toroweap and Coconino Formations, 15 to 55 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 7,000 to 8,500 feet (2,134 to 2,591 meters)

Mean annual precipitation: 25 to 33 inches (635 to 838 millimeters)

Mean annual air temperature: 36 to 45 degrees F (2 to 7 degrees C)

Mean annual soil temperature: 38 to 47 degrees F (4 to 9 degrees C)

Frost-free period: 70 to 105 days

Map Unit Composition

Lithic Haplustolls and similar soils: 40 percent

Udic Haplustolls and similar soils: 40 percent

Rock outcrop: 20 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Lithic Haplustolls soils

Taxonomic classification: Lithic Haplustolls

Geomorphic position: pockets and ledges of canyon sidewalls of plateau escarpments

Parent material: colluvium derived from limestone, sandstone, and shale

Slope: 15 to 55 percent

Depth to restrictive feature: 8 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-9

Ecological site name: Sedimentary Cliffs 25-33" p.z.

Ecosystem site number: 035XI901AZ

Present native vegetation: Douglas-fir, Gambel oak, New Mexico locust, other evergreen trees, white fir, Symphoricarpos, Utah serviceberry

Land capability (nonirrigated): 5c

Taxonomic Unit Description

Type Location: In Bright Angel Canyon; 2,051 feet northeast of Transept Trail Campgrounds; 36 degrees, 12 minutes, 58 seconds north latitude; 112 degrees, 3 minutes, 15 seconds west longitude.

A1—0 to 2 inches; brown (10YR 4/3) very stony sandy loam; very dark brown (10YR 2/2) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and common medium roots; many very fine and fine tubular pores; 10 percent gravel, 20 percent cobble, and 20 percent stone; slightly effervescent; slightly alkaline (pH 7.8); abrupt smooth boundary.

A2—2 to 6 inches; brown (10YR 4/3) very stony sandy loam; very dark brown (10YR 2/2) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine, common medium and few coarse roots; many very fine and fine and few

medium tubular pores; 5 percent gravel, 20 percent cobble, and 20 percent stone; slightly effervescent; slightly alkaline (pH 7.8); clear smooth boundary.

A3—6 to 14 inches; brown (10YR 5/3) very stony sandy loam; dark brown (10YR 3/3) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine through coarse roots; common fine tubular pores; 20 percent cobble, 40 percent stone; slightly effervescent; slightly alkaline (pH 7.8); abrupt irregular boundary.

R—14 inches; limestone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Udic Haplustolls soils

Taxonomic classification: Udic Haplustolls

Geomorphic position: pockets and chutes on colluvial slopes on plateau escarpments

Parent material: colluvium derived from limestone, sandstone, and shale

Slope: 15 to 55 percent

Depth to restrictive feature: 40 to 60 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-9

Ecological site name: Sedimentary Cliffs 25-33" p.z.

Ecosystem site number: 035XI901AZ

Present native vegetation: Douglas-fir, Gambel oak, New Mexico locust, other evergreen trees, white fir, Symphoricarpus, Utah serviceberry

Land capability (nonirrigated): 5c

Taxonomic Unit Description

Type Location: In Bright Angel Canyon; 2,433 feet east of Transept Trail Campgrounds; 36 degrees, 12 minutes, 58 seconds north latitude; 112 degrees, 3 minutes, 10 seconds west longitude.

A1—0 to 2 inches; brown (10YR 4/3) very stony loam; very dark brown (10YR 2/2) moist; moderate fine granular structure; soft, very friable, nonsticky and

nonplastic; many very fine and fine and common medium roots; common very fine and fine tubular pores; 10 percent gravel, 20 percent cobble, and 25 percent stone; noneffervescent; slightly alkaline (pH 7.4); abrupt smooth boundary.

A2—2 to 6 inches; brown (10YR 4/3) extremely stony loam; very dark brown (10YR 2/2) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and common medium and coarse roots; common very fine and fine tubular pores; 15 percent gravel, 25 percent cobble, and 25 percent stone; noneffervescent; slightly alkaline (pH 7.4); clear smooth boundary.

Bw—6 to 12 inches; brown (10YR 5/3) very cobbly sandy loam; dark brown (10YR 3/3) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine through coarse roots; common fine and few medium tubular pores; 10 percent gravel, 25 percent cobble, and 10 percent stone; slightly effervescent; slightly alkaline (pH 7.8); clear smooth boundary.

2C1—12 to 30 inches; light yellowish brown (10YR 6/4) very stony sandy loam; yellowish brown (10YR 5/4) moist; massive; soft, very friable, nonsticky and nonplastic; common fine through coarse roots, common fine and few medium tubular pores; 10 percent gravel, 25 percent cobble, and 15 percent stone; strongly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

2C2—30 to 50 inches; light yellowish brown (10YR 6/4) very cobbly sandy loam; yellowish brown (10YR 5/4) moist; soft, very friable, nonsticky and nonplastic; few medium and coarse roots; few medium tubular pores; 15 percent gravel, 30 percent cobble, and 10 percent stone; strongly effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

2R—50 inches; limestone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Rock outcrop

Summits and sideslopes of low hills and ridges

66—Lithic Torriorthents-Lithic Calciargids complex, Bright Angel and Tapeats Formations, thermic, 2 to 55 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 1,200 to 1,600 feet (366 to 488 meters)

Mean annual precipitation: 3 to 6 inches (76 to 152 millimeters)

Mean annual air temperature: 70 to 75 degrees F (21 to 24 degrees C)

Mean annual soil temperature: 72 to 77 degrees F (23 to 26 degrees C)

Frost-free period: 300 to 360 days

Map Unit Composition

Lithic Torriorthents and similar soils: 80 percent

Lithic Calciargids and similar soils: 20 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Lithic Torriorthents soils

Taxonomic classification: Lithic Torriorthents

Geomorphic position: flat to very steep pediments of the Bright Angel Shale

Parent material: residuum weathered from calcareous shale

Slope: 2 to 55 percent

Depth to restrictive feature: 6 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 30

Land Resource Unit: 30-1

Ecological site name: Channery Hills 3-6" p.z.

Ecosystem site number: 030XA119AZ

Present native vegetation: white brittlebush, creosotebush, Opuntia, desert senna, white bursage

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 4,395 feet southwest of Columbine Falls; 36 degrees, 6

minutes, 10 seconds north latitude; 113 degrees, 55 minutes, 47 seconds west longitude.

A1—0 to 1 inch; very pale brown (10YR 7/3) extremely channery loam; brown (10YR 5/3) moist; strong thin platy structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; many very fine and fine and few medium vesicular pores; 40 percent channers, 10 percent cobble, and 10 percent stone; strongly effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

A2—1 to 3 inches, brown (10YR 5/3) extremely channery loam; brown (10YR 4/3) moist; weak medium subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; few fine and medium irregular pores; many coarse clay films bridging sand grains; 70 percent channers; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

Cr—3 to 6 inches; brown (7.5YR 4/3) extremely channery loam; brown (7.5YR 4/3) moist; massive; slightly hard, friable, moderately sticky and moderately plastic; few very fine roots; many very fine through medium interstitial pores; 90 percent weathered shale channers; violently effervescent; moderately alkaline (pH 8.4).

R—6 inches; Bright Angel shale bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Lithic Calciargids soils

Taxonomic classification: Lithic Calciargids

Geomorphic position: flat to very steep pediments of the Tapeats Sandstone

Parent material: residuum weathered from calcareous sandstone

Slope: 2 to 15 percent

Depth to restrictive feature: 10 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 30

Land Resource Unit: 30-1

Ecological site name: Channery Hills 3-6" p.z.

Ecosystem site number: 030XA119AZ

Present native vegetation: white brittlebush, creosotebush, Opuntia, desert senna, white bursage

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon, 1.08 miles southwest of Triumphal Arch Rapids, 35 degrees, 57 minutes, 13 seconds north latitude; 113 degrees, 44 minutes, 35 seconds west longitude.

A—0 to 2 inches; light brown (7.5YR 6/4) very gravelly loam; brown (7.5YR 4/4) moist; moderate moderately thick platy structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; many very fine vesicular pores; 25 percent gravel, 15 percent cobble; strongly effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Btk1—2 to 5 inches; reddish brown (5YR 5/4) very gravelly clay loam; yellowish red (5YR 4/3) moist; strong fine subangular blocky structure; soft, very friable, very sticky and very plastic; common very fine and fine roots; common fine tubular pores; common faint clay films on the faces of peds; common coarse soft masses of calcium carbonate; 50 percent gravel, 5 percent cobble; noneffervescent matrix; moderately alkaline (pH 8.4); clear wavy boundary.

Btk2—5 to 11 inches; yellowish red (5YR 5/4) very channery clay; yellowish red (5YR 4/3) moist; strong fine subangular blocky structure; soft, very friable, very sticky and very plastic; common very fine and fine roots; common fine tubular pores; common faint clay films on the faces of peds; common coarse soft masses of calcium carbonate; 5 percent gravel, 40 percent channers, 5 percent cobble; noneffervescent matrix; moderately alkaline (pH 8.4); clear wavy boundary.

R—11 inches; sandstone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit

description is representative of what may be found in this landscape position.

67—Lithic Torriorthents-Lithic Calciargids complex, Bright Angel and Tapeats Formations, thermic, 2 to 55 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 1,600 to 2,500 feet (488 to 762 meters)

Mean annual precipitation: 6 to 9 inches (152 to 229 millimeters)

Mean annual air temperature: 64 to 70 degrees F (18 to 21 degrees C)

Mean annual soil temperature: 66 to 72 degrees F (20 to 23 degrees C)

Frost-free period: 230 to 280 days

Map Unit Composition

Lithic Torriorthents and similar soils: 70 percent

Lithic Calciargids and similar soils: 30 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Lithic Torriorthents soils

Taxonomic classification: Lithic Torriorthents

Geomorphic position: flat to very steep pediments of the Bright Angel Shale

Parent material: residuum weathered from calcareous shale

Slope: 2 to 55 percent

Depth to restrictive feature: 6 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 30

Land Resource Unit: 30-2

Ecological site name: Channery Hills 6-9" p.z.

Ecosystem site number: 030XB219AZ

Present native vegetation: white bursage,

creosotebush, white brittlebush, Opuntia, desert senna

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 3,161 feet east of Burnt Canyon, 35 degrees, 58 minutes, 0 seconds north latitude; 113 degrees, 44 minutes, 23 seconds west longitude.

A—0 to 2 inches; yellowish brown (10YR 5/4) very channery loam; brown (10YR 4/3) moist; weak thin platy structure; soft, very friable, nonsticky and nonplastic; common very fine roots; common very fine and fine tubular pores; 50 percent channers, 5 percent flagstones; strongly effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bw—2 to 9 inches; brown (10YR 5/3) very channery loam; brown (10YR 4/3) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine through medium roots; common fine and medium tubular pores; 45 percent channers; violently effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

Bk—9 to 19 inches; brown (10YR 5/3) extremely channery loam; brown (10YR 4/3) moist; moderate fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine through coarse roots; common fine through coarse tubular pores; common thin coats of calcium carbonate on the undersides of rock fragments; 60 percent channers; violently effervescent; strongly alkaline (pH 8.6); abrupt irregular boundary.

R—19 inches; Bright Angel shale bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Lithic Calciargids soils

Taxonomic classification: Lithic Calciargids

Geomorphic position: flat to very steep pediments of the Tapeats Sandstone

Parent material: residuum weathered from calcareous sandstone

Slope: 2 to 8 percent

Depth to restrictive feature: 10 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 30

Land Resource Unit: 30-2

Ecological site name: Channery Hills 6-9" p.z.

Ecosystem site number: 030XB219AZ

Present native vegetation: white bursage, creosotebush, white brittlebush, Opuntia, desert senna

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 5,074 feet northeast of Burnt Canyon, 35 degrees, 57 minutes, 35 seconds north latitude; 113 degrees, 44 minutes, 16 seconds west longitude.

A—0 to 2 inches; light yellowish brown (10YR 6/4) extremely gravelly sandy loam; dark yellowish brown (10YR 4/4) moist; moderate thin platy structure; soft, very friable, slightly sticky and slightly plastic; few very fine and fine roots; many very fine and fine vesicular and few very fine tubular pores; 60 percent gravel, 15 percent cobble, and 5 percent stone; strongly effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Btk1—2 to 9 inches; strong brown (7.5YR 5/6) extremely gravelly sandy clay loam; strong brown (7.5YR 4/6) moist; strong very fine and fine subangular blocky structure; slightly hard; very friable, very sticky and very plastic; many very fine and fine roots; many very fine and fine and few medium tubular pores; many faint clay films on faces of pedis and lining pores; common thin through thick coats of calcium carbonate on the undersides of rock fragments; 65 percent gravel; violently effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

Btk2—9 to 12 inches; light brown (7.5YR 6/4) very gravelly sandy clay loam; brown (7.5YR 4/4) moist; weak very fine and fine subangular blocky structure; soft, very friable, moderately sticky and moderately plastic; many very fine and fine and few coarse roots; common very fine through medium tubular pores; common faint clay films lining pores; common soft masses of calcium carbonate; common moderately thick and thick coats and pendants of calcium carbonate on the undersides and sides of rock fragments; 50 percent gravel; violently effervescent; strongly alkaline (pH 8.6); clear wavy boundary.

Cr—12 to 17 inches; light yellowish brown (10YR 6/4)

extremely gravelly sandy clay loam; dark yellowish brown (10YR 4/4) moist; massive; soft, very friable, slightly sticky and moderately plastic; common fine and medium roots; 40 percent gravel, 20 percent cobble; violently effervescent; strongly alkaline (pH 8.6); abrupt irregular boundary.

R—17 inches; Tapeats sandstone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

68—Lithic Torriorthents-Rock outcrop complex, Dox Formation, 15 to 60 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,500 to 4,500 feet (1,067 to 1,372 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 200 to 240 days

Map Unit Composition

Lithic Torriorthents and similar soils: 55 percent
Rock outcrop: 45 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Lithic Torriorthents soils

Taxonomic classification: Lithic Torriorthents

Geomorphic position: pockets on ledges

Parent material: colluvium and/or residuum weathered from sandstone and shale

Slope: 15 to 60 percent

Depth to restrictive feature: 4 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Sedimentary Cliffs 6-10" p.z.

Ecosystem site number: 035XE516AZ

Present native vegetation: Torrey Mormon tea, shadscale saltbush, beavertail pricklypear, blue threeawn, bush muhly

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 2,931 feet northeast of Espejo Creek; 36 degrees, 7 minutes, 28 seconds north latitude; 111 degrees, 49 minutes, 5 seconds west longitude.

C—0 to 8 inches; weak red (10R 4/4) extremely channery sandy loam; dusky red (10R 3/3) moist; single grain; loose, nonsticky and nonplastic; common very fine roots; many very fine and fine irregular pores; 60 percent channers; slightly effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

R—8 inches; sandstone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Rock outcrop

Steep pediments of dipping, thinly bedded sandstone and shale of the Dox Formation

69—Lithic Torriorthents-Rock outcrop complex, Esplanade Formation, 2 to 8 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,200 to 4,100 feet (975 to 1,250 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 210 to 280 days

Map Unit Composition

Lithic Torriorthents and similar soils: 70 percent

Rock outcrop: 30 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Lithic Torriorthents soils

Taxonomic classification: Lithic Torriorthents

Geomorphic position: Concavities and pockets in pediments of the Esplanade sandstone

Parent material: colluvium derived from calcareous sandstone and/or eolian deposits derived from mixed and/or residuum weathered from calcareous sandstone

Slope: 2 to 8 percent

Depth to restrictive feature: 4 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Sandstone Upland 6-10" p.z.

Ecosystem site number: 035XE510AZ

Present native vegetation: desert needlegrass, Bigelow sagebrush, ephedra, galleta, turbinella oak, other evergreen trees

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Esplanade; 1.78 miles northeast of Cane Spring; 36 degrees, 10 minutes, 40 seconds north latitude; 113 degrees, 13 minutes, 40 seconds west longitude.

A—0 to 1 inch; red (2.5YR 5/6) very gravelly fine sandy loam; red (2.5YR 5/6) moist; moderate thick platy structure parting to moderate fine granular; soft, very friable, nonsticky and slightly plastic; few very fine roots; many very fine irregular pores; 40 percent

gravel, 10 percent cobble; strongly effervescent; slightly alkaline (pH 7.8); abrupt smooth boundary.

C—1 to 14 inches; yellowish red (5YR 5/6) fine sandy loam; yellowish red (5YR 4/6) moist; massive; slightly hard, friable, slightly sticky and moderately plastic; common very fine roots; common very fine tubular pores; 5 percent gravel; strongly effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

R—14 inches; sandstone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Rock outcrop

Nearly flat to gently rolling pediments of the Esplanade sandstone

70—Lithic Torriorthents-Rock outcrop complex, Muav and Redwall Formations, 15 to 70 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 1,600 to 3,400 feet (487 to 1,036 meters)

Mean annual precipitation: 6 to 9 inches (152 to 229 millimeters)

Mean annual air temperature: 64 to 70 degrees F (18 to 21 degrees C)

Mean annual soil temperature: 66 to 72 degrees F (20 to 23 degrees C)

Frost-free period: 230 to 280 days

Map Unit Composition

Lithic Torriorthents and similar soils: 70 percent

Rock outcrop: 30 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Lithic Torriorthents soils

Taxonomic classification: Lithic Torriorthents

Geomorphic position: colluvial slopes on ledges

Parent material: colluvium and/or residuum weathered from limestone

Slope: 15 to 70 percent

Depth to restrictive feature: 8 to 14 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 30

Land Resource Unit: 30-2

Ecological site name: Limestone Hills 6-9" p.z.

Ecosystem site number: 030XB210AZ

Present native vegetation: Nevada Mormon tea, big galleta, bush muhly, Opuntia, rayless brittlebush, white ratany, agave

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 1.17 miles south of Balanced Rock Canyon; 36 degrees, 9 minutes, 38 seconds north latitude; 113 degrees, 56 minutes, 3 seconds west longitude.

A—0 to 1 inch; light yellowish brown (10YR 6/4) very gravelly very fine sandy loam; dark yellowish brown (10YR 4/4) moist; weak thick platy structure parting to moderate fine subangular blocky; slightly hard, very friable, nonsticky and nonplastic; many very fine roots; common very fine irregular pores; 40 percent gravel, 10 percent cobble, 5 percent stone; violently effervescent, moderately alkaline (pH 8.0); abrupt smooth boundary.

Bw—1 to 6 inches; light brown (7.5YR 6/4) very gravelly silt loam; brown (7.5YR 4/4) moist; weak thick platy structure parting to moderate fine subangular blocky; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine irregular and few fine tubular pores; 35 percent gravel; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bk—6 to 9 inches; light brown (7.5YR 6/4) and pink (7.5YR 7/4) very gravelly silt loam; brown (7.5YR 5/4) moist; massive; soft, very friable, nonsticky and nonplastic; many very fine and common fine roots; many very fine irregular and few fine tubular pores; 35

percent gravel; common very thin calcium carbonate coatings on rock fragments; common medium soft bodies of pink (7.5YR 7/4) silt loam; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

R—9 inches; fractured limestone bedrock with few roots and few calcite crystals in cracks; uppermost bedrock surface has a thin coating of calcium carbonate.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Rock outcrop

Vertical, tall cliffs and canyon walls of the Muav and Redwall Formations

71—Lithic Torriorthents-Typic Torriorthents-Rock outcrop complex, Hermit Formation, 3 to 85 percent slopes

Map Unit Setting

Landform: hill

Elevation: 1,200 to 1,600 feet (366 to 487 meters)

Mean annual precipitation: 6 to 9 inches (152 to 229 millimeters)

Mean annual air temperature: 64 to 70 degrees F (18 to 21 degrees C)

Mean annual soil temperature: 66 to 72 degrees F (20 to 23 degrees C)

Frost-free period: 230 to 280 days

Map Unit Composition

Lithic Torriorthents and similar soils: 45 percent

Typic Torriorthents and similar soils: 35 percent

Rock outcrop: 20 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major

components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Lithic Torriorthents soils

Taxonomic classification: Lithic Torriorthents
Geomorphic position: ridges and escarpments
Parent material: colluvium derived from mudstone
Slope: 3 to 85 percent
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Major Land Resource Area: 30
Land Resource Unit: 30-2
Ecological site name: Breaks 6-9" p.z.
Ecosystem site number: 030XB204AZ
Present native vegetation: white bursage, Nevada Mormon tea, big galleta, creosotebush, blue threeawn
Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 1.93 miles west of Gods Pocket; 36 degrees, 11 minutes, 16 seconds north latitude; 113 degrees, 59 minutes, 24 seconds west longitude,

A—0 to 2 inches; red (2.5YR 4/6) very channery fine sandy loam; dark red (2.5YR 3/6) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine roots; few very fine tubular pores; 55 percent channers; strongly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

C—2 to 6 inches; red (2.5YR 4/6) extremely channery fine sandy loam; red (2.5YR 4/6) moist; massive, soft, very friable, slightly sticky and moderately plastic; common very fine and fine roots; few fine tubular pores; 80 percent channers; strongly effervescent; moderately alkaline (pH 8.0); abrupt wavy boundary.

R—6 inches; fractured sandstone of the Hermit Formation.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit

description is representative of what may be found in this landscape position.

Typic Torriorthents soils

Taxonomic classification: Typic Torriorthents
Geomorphic position: summits and side slopes of colluvial slopes
Parent material: colluvium derived from limestone and siltstone
Slope: 3 to 85 percent
Depth to restrictive feature: 20 to 50 inches to bedrock (lithic)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Major Land Resource Area: 30
Land Resource Unit: 30-2
Ecological site name: Limestone Hills 6-9" p.z.
Ecosystem site number: 030XB210AZ
Present native vegetation: Nevada Mormon tea, big galleta, bush muhly, Opuntia, rayless brittlebush, white ratany, agave
Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 1,719 feet southwest of Gods Pocket; 36 degrees, 11 minute 18 seconds north latitude; 113 degrees, 59 minutes, 40 seconds west longitude.

A—0 to 6 inches; strong brown (7.5YR 5/6) extremely cobbly fine sandy loam, brown (7.5YR 4/4) moist; weak fine platy structure; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; few fine tubular pores; 10 percent gravel, 60 percent cobble; slightly effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

C—6 to 28 inches; strong brown (7.5YR 5/6) extremely stony loam, strong brown (7.5YR 4/6) moist; massive; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; common very fine and fine tubular pores; 10 percent gravel, 30 percent cobble, 30 percent stone; strongly effervescent; moderately alkaline (pH 8.2); clear wavy boundary.

2C—28 to 37 inches; yellowish red (5YR 5/6) extremely gravelly sandy loam, dark red (2.5YR 3/6) moist; massive; soft, very friable, nonsticky and nonplastic; few fine roots; few fine tubular pores; 70 percent gravel; strongly effervescent; moderately alkaline (pH 8.0); abrupt irregular boundary.

2R—37 inches; hard sandstone of the Hermit Formation.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Rock outcrop

Ridges and escarpments of soft mudstone of the Hermit Formation

72—Lithic Ustic Torriorthents-Rock outcrop complex, Hermit Formation, 20 to 50 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,500 to 5,600 feet (1,372 to 1,707 meters)

Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)

Mean annual air temperature: 55 to 57 degrees F (13 to 14 degrees C)

Mean annual soil temperature: 57 to 59 degrees F (15 to 16 degrees C)

Frost-free period: 145 to 150 days

Map Unit Composition

Lithic Ustic Torriorthents and similar soils: 60 percent
Rock outcrop: 40 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Lithic Ustic Torriorthents soils

Taxonomic classification: Lithic Ustic Torriorthents

Geomorphic position: pockets and ledges on steep pediments

Parent material: residuum and colluvium derived from fine-grained sandstone

Slope: 20 to 50 percent

Depth to restrictive feature: 4 to 10 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: sandstone Hills, Calcareous 10-14" p.z.

Ecosystem site number: 035XC354AZ

Present native vegetation: blackbrush, Stansbury cliffrose, turbinella oak, green Mormon tea, other evergreen trees, Achnatherum, Hesperostipa

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: 1,340 feet west of Mollies Nipple; 36 degrees, 4 minutes, 50 seconds north latitude; 113 degrees, 23 minutes, 8 seconds west longitude.

A—0 to 1 inch; red (2.5YR 4/6) extremely channery fine sandy loam; dark red (2.5YR 3/6) moist; weak medium platy structure parting to moderate medium granular; soft, very friable, slightly sticky and nonplastic; common very fine and fine and few medium roots occurring in pockets; common very fine irregular and few fine tubular pores; 50 percent channers, 20 percent gravel, 15 percent flagstone, and 5 percent cobble; noneffervescent; neutral (pH 7.0); abrupt smooth boundary.

C—1 to 5 inches; red (2.5YR 4/6) extremely flaggy fine sandy loam; dark red (2.5YR 3/6) moist; weak medium platy structure parting to moderate medium granular; soft, very friable, slightly sticky and nonplastic; common very fine and fine and few medium roots occurring in pockets; common very fine irregular and few fine tubular pores; 40 percent channers, 30 percent flagstone; noneffervescent; neutral (pH 7.0); abrupt smooth boundary.

R—5 inches; hard, fine-grained sandstone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as

erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Rock outcrop

Steep pediments of the Hermit Formation on escarpments and canyon walls

73—Lithic Ustic Torriorthents-Rock outcrop complex, Supai Group, 15 to 55 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,500 to 7,000 feet (1,677 to 2,134 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)

Mean annual soil temperature: 50 to 54 degrees F (11 to 13 degrees C)

Frost-free period: 135 to 150 days

Map Unit Composition

Lithic Ustic Torriorthents and similar soils: 70 percent
Rock outcrop: 30 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Lithic Ustic Torriorthents soils

Taxonomic classification: Lithic Ustic Torriorthents

Geomorphic position: pockets on ledges

Parent material: colluvium derived from sandstone and siltstone

Slope: 15 to 55 percent

Depth to restrictive feature: 4 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Sedimentary Cliffs 13-17" p.z.

Ecosystem site number: 035XF601AZ

Present native vegetation: littleleaf mountain-mahogany, turbinella oak, other evergreen trees, pointleaf manzanita, desert needlegrass

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 3,731 feet south of Hundred and Ninetythree Mile Creek; 36 degrees, 4 minutes, 47 seconds north latitude; 113 degrees, 13 minutes, 46 seconds west longitude.

A—0 to 2 inches; reddish brown (5YR 5/4) extremely cobbly loam; reddish brown (5YR 4/3) moist; moderate fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine through coarse roots; many fine tubular pores; 40 percent gravel, 35 percent cobble, and 5 percent stone; strongly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bw—2 to 10 inches; yellowish red (5YR 5/6) very cobbly loam; reddish brown (5YR 5/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine through coarse roots; common fine tubular pores; 15 percent gravel, 25 percent cobble, and 5 percent stone; strongly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

C—10 to 19 inches; yellowish red (5YR 5/6) extremely cobbly sandy loam; reddish brown (5YR 5/4) moist; massive; soft, very friable, nonsticky and nonplastic; common medium and coarse roots; few fine tubular pores; 40 percent gravel, 25 percent cobble, and 5 percent stone; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

R—19 inches; fractured sandstone bedrock with accumulations of calcium carbonate inside the fractures.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as

erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Rock outcrop

Escarpments of thick horizontal ledges of the Supai Group

74—Lithic Ustic Torriorthents-Udic Haplustolls-Rock outcrop complex, Kaibab, Toroweap and Coconino Formations, 15 to 55 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,000 to 7,500 feet (1,524 to 2,286 meters)

Mean annual precipitation: 13 to 33 inches (330 to 838 millimeters)

Mean annual air temperature: 36 to 48 degrees F (2 to 9 degrees C)

Mean annual soil temperature: 38 to 50 degrees F (4 to 11 degrees C)

Frost-free period: 80 to 150 days

Map Unit Composition

Lithic Ustic Torriorthents and similar soils: 50 percent

Udic Haplustolls and similar soils: 35 percent

Rock outcrop: 15 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Lithic Ustic Torriorthents soils

Taxonomic classification: Lithic Ustic Torriorthents

Geomorphic position: colluvial slopes on ledges and toeslopes of plateau escarpments

Parent material: colluvium derived from limestone and sandstone

Slope: 15 to 55 percent

Depth to restrictive feature: 4 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Sedimentary Cliffs 13-17" p.z.

Ecosystem site number: 035XF601AZ

Present native vegetation: littleleaf mountain-mahogany, turbinella oak, other evergreen trees, pointleaf manzanita, desert needlegrass

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: Below the Coconino Plateau; 914 feet south of Lipan Point; 36 degrees, 1 minute, 50 seconds north latitude; 111 degrees, 51 minutes, 8 seconds west longitude.

A—0 to 1 inch; pale brown (10YR 6/3) extremely gravelly very fine sandy loam, brown (10YR 5/3) moist; single grain; loose, nonsticky and nonplastic; many very fine irregular pores; 85 percent limestone gravel; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bw—1 to 6 inches; pale brown (10YR 6/3) extremely gravelly very fine sandy loam, brown (10YR 5/3) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine irregular pores; 75 percent limestone gravel; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

R—6 inches; limestone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Udic Haplustolls soils

Taxonomic classification: Udic Haplustolls

Geomorphic position: colluvial slopes on ledges and toeslopes of plateau escarpments

Parent material: colluvium derived from limestone and sandstone

Slope: 15 to 55 percent

Depth to restrictive feature: 20 to 60 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-9

Ecological site name: Sedimentary Cliffs 25-33" p.z.

Ecosystem site number: 035XI901AZ

Present native vegetation: Douglas-fir, Gambel oak, New Mexico locust, other evergreen trees, white fir, Symphoricarpus, Utah serviceberry

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: Below the Coconino Plateau; 4,450 feet south of Yaki Point; 36 degrees, 2 minutes, 47 seconds north latitude; 112 degrees, 4 minutes, 57 seconds west longitude.

A—0 to 4 inches; very dark grayish brown (10YR 3/2) very cobbly fine sandy loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and common medium and coarse roots; common fine and medium interstitial and tubular pores; 25 percent gravel, 30 percent limestone cobble; slightly effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bw1—4 to 20 inches; very dark grayish brown (10YR 3/2) very gravelly fine sandy loam, very dark brown (10YR 2/2) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine through coarse roots; common fine and medium interstitial and tubular pores; 50 percent gravel, 15 percent cobble; slightly effervescent; moderately alkaline (pH 8.2); clear wavy boundary.

Bw2—20 to 36 inches; very dark grayish brown (10YR 3/2) very cobbly fine sandy loam, very dark brown (10YR 2/2) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine through coarse roots; common fine and medium interstitial and tubular pores; 50 percent gravel, 35 percent cobble; slightly effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

R—36 inches; fractured limestone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Rock outcrop

Vertical cliffs and escarpments

75—Lostman family-Harrisburg complex, 1 to 5 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,500 to 4,500 feet (1,067 to 1,372 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 61 degrees F (14 to 16 degrees C)

Mean annual soil temperature: 59 to 63 degrees F (16 to 18 degrees C)

Frost-free period: 180 to 200 days

Map Unit Composition

Lostman family and similar soils: 50 percent

Harrisburg and similar soils: 45 percent

Minor components: 5 percent

- Soils containing more than 35 percent rock fragments
- Soils that have fine sandy loam surfaces

Properties and Qualities

Lostman family soils

Taxonomic classification: Coarse-loamy, mixed, superactive, thermic Typic Haplocambids

Geomorphic position: young stream terraces in broad ephemeral drainageways

Parent material: alluvium

Slope: 1 to 5 percent

Surface fragments: about 5 percent gravel

Drainage class: Well drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 8.9

Shrink-swell potential: about 1.5 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Low

Hydrologic group: B

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Sandy Loam Upland 6-10" p.z.

Ecosystem site number: 035XE514AZ

Present native vegetation: black grama, bush muhly,
desert needlegrass, banana yucca, catclaw
acacia, green Mormon tea

Land capability (nonirrigated): 7c

Taxonomic Unit Description 7c

slightly hard, friable, slightly sticky and slightly plastic; common fine roots; common fine tubular pores; common medium soft seams and soft masses of calcium carbonate; 5 percent gravel; violently effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bk2—34 to 39 inches; light yellowish brown (10YR 6/4) very fine sandy loam; dark yellowish brown (10YR 4/4) moist; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; common fine tubular pores; common medium soft seams and soft masses of calcium carbonate; 5 percent gravel; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bkm—39 inches; indurated petrocalcic horizon.

Range in Characteristics

Depth to petrocalcic horizon: 20 to 40 inches

Average content of rock fragments in the control section: less than 15 percent

Clay content in the control section: 12 to 18 percent

76—Luzena-Kellypoint complex, 2 to 35 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,800 to 6,600 feet (1,767 to 2,011 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)

Mean annual soil temperature: 50 to 54 degrees F (11 to 13 degrees C)

Frost-free period: 135 to 150 days

Map Unit Composition

Luzena and similar soils: 60 percent

Kellypoint and similar soils: 25 percent

Minor components: 15 percent

- Rock outcrop
- Albers soils
- Soils in drainageways that are subject to occasional flooding
- Phizphre soils
- Luzena soils that have very bouldery surfaces

Properties and Qualities

Luzena soils

Taxonomic classification: Clayey, smectitic, mesic Lithic Argiustolls

Geomorphic position: shoulders, side slopes and escarpments of basalt flows

Parent material: colluvium and/or residuum weathered from basalt

Slope: 2 to 35 percent

Surface fragments: about 5 percent boulders, about 30 percent coarse gravel, about 25 percent cobbles, about 10 percent stones

Depth to restrictive feature: 10 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.13 in/hr (slow)

Available water capacity total inches: 2.2

Shrink-swell potential: about 7.0 LEP (high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Basalt Slopes (JUOS, PIED) 13-17" p.z.

Ecosystem site number: 035XF624AZ

Present native vegetation: Utah juniper, needleandthread, Colorado pinyon, Stansbury cliffrose, galleta, Wyoming big sagebrush

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Shivwits Plateau; 1.13 miles southwest of Deer Flat Tank, 35 degrees, 57 minutes, 2 seconds north latitude; 113 degrees, 30 minutes, 28 seconds west longitude.

A—0 to 1 inch; dark brown (7.5YR 3/3) extremely cobbly silty clay loam; very dark brown (7.5YR 2.5/3) moist; moderate very fine and fine granular structure; soft, very friable, very sticky and moderately plastic; few very fine and fine roots; many very fine irregular pores; 30 percent gravel, 25 percent cobble, 5 percent stone; noneffervescent; neutral (pH 7.0); abrupt smooth boundary.

AB—1 to 3 inches; dark brown (7.5YR 3/3) cobbly silty clay loam; very dark brown (7.5YR 2.5/3) moist; strong

medium subangular blocky structure parting to strong very fine granular; hard, friable, very sticky and very plastic; many very fine and common fine roots; 5 percent gravel, 10 percent cobble; many very fine irregular and few fine tubular pores; common faint clay films on faces of peds and lining pores; noneffervescent; neutral (pH 7.0); abrupt wavy boundary.

Bt1—3 to 8 inches; brown (7.5YR 4/3) clay; dark brown (7.5YR 3/2) moist; strong coarse subangular blocky structure parting to strong medium and fine subangular blocky; very hard, firm, very sticky and very plastic; few very fine and medium and common fine roots; few fine tubular pores; 5 percent gravel; common faint clay films on faces of peds; noneffervescent; neutral (pH 6.8); clear smooth boundary.

Bt2—8 to 19 inches; brown (7.5YR 4/3) clay; dark brown (7.5YR 3/3) moist; strong coarse prismatic structure parting to weak medium and coarse subangular blocky; very hard, very firm, very sticky and very plastic; common medium and few fine roots; few very fine and fine tubular pores; 5 percent gravel; common faint clay films on faces of peds; noneffervescent; neutral (pH 6.8); abrupt irregular boundary.

R—19 inches; basalt bedrock.

Range in Characteristics

Depth to bedrock: 10 to 20 inches
Reaction: slightly acid to moderately alkaline
Organic matter: 1 to 3 percent

A horizon

Hue: 5YR, 7.5YR, 10YR
Value: 3 through 5 dry, 2.5 or 3 moist
Chroma: 2 or 3, dry or moist

Bt horizons

Hue: 5YR, 7.5YR
Value: 3 through 5 dry, 2.5 or 3 moist
Chroma: 2 or 3, dry or moist
Texture: clay loam, clay (35 to 59 percent clay)
Rock fragments: 0 to 5 percent

Kellypoint soils

Taxonomic classification: Fine, smectitic, mesic Vertic Argiustolls

Geomorphic position: summits and concavities on basalt flows

Parent material: residuum weathered from basalt

Slope: 2 to 15 percent

Surface fragments: about 10 percent stones, about 25 percent cobbles, about 20 percent coarse gravel

Depth to restrictive feature: 24 to 32 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.01 in/hr (very slow)

Available water capacity total inches: 3.3

Shrink-swell potential: about 10.0 LEP (very high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Basalt Upland (JUOS) 13-17" p.z.

Ecosystem site number: 035XF620AZ

Present native vegetation: Utah juniper, muttongrass, Colorado pinyon, Stansbury cliffrose, bottlebrush squirreltail, turbinella oak

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Shivwits Plateau; 4,412 feet northeast of Deer Flat Tank, 35 degrees, 57 minutes, 15 seconds north latitude; 113 degrees, 28 minutes, 19 seconds west longitude.

A—0 to 2 inches; dark brown (7.5YR 3/2) very cobbly silty clay loam; very dark brown (7.5YR 2.5/2) moist; strong very fine granular structure; soft, very friable, moderately sticky and moderately plastic; few very fine roots; many very fine and fine irregular pores; 20 percent gravel, 25 percent cobble, 10 percent stone; noneffervescent; neutral (pH 6.8); abrupt smooth boundary.

Bt—2 to 5 inches; dark brown (7.5YR 3/2) stony silty clay loam; very dark brown (7.5YR 2.5/3) moist; strong medium subangular blocky structure; hard, friable, very sticky and very plastic; common very fine through coarse roots; common very fine and fine and few medium and coarse tubular pores; 5 percent gravel, 5 percent cobble, 5 percent stone; few faint clay films on faces of peds; noneffervescent; neutral (pH 6.8); clear wavy boundary.

Btss1—5 to 14 inches; dark brown (7.5YR 3/3) clay; very dark brown (7.5YR 2.5/3) moist; strong medium prismatic structure parting to strong medium angular blocky; very hard, firm, very sticky and very plastic; common fine through coarse roots; few fine tubular pores; 5 percent gravel, 5 percent cobble; many intersecting slickensides; many faint clay films on

faces of peds; noneffervescent; neutral (pH 6.8); clear wavy boundary.

Btss2—14 to 28 inches; dark brown (7.5YR 3/2) cobbly clay; very dark brown (7.5YR 2.5/3) moist; strong coarse prismatic structure parting to strong medium and coarse angular blocky; very hard, firm, very sticky and very plastic; few fine and medium roots; few fine tubular pores; 5 percent gravel, 15 percent cobble; many intersecting slickensides; many faint clay films on faces of peds; noneffervescent; neutral (pH 6.8); abrupt irregular boundary.

R—28 inches; fractured basalt bedrock.

Range in Characteristics

Depth to bedrock: 24 to 32 inches

Depth to argillic horizon: 1 to 3 inches

Rock fragments: 10 to 20 percent in the particle size control section

A horizon

Hue: 7.5YR, 10YR

Value: 3 or 4 dry, 2.5 or 3 moist

Chroma: 2 or 3, dry or moist

Organic matter: 2 through 4 percent

Bt horizon

Value: 3 or 4 dry, 2.5 or 3 moist

Chroma: 2 or 3, dry or moist

Clay content: 35 to 45 percent

Texture: silty clay loam, clay

Organic matter: 1 to 2 percent

Btss horizon

Hue: 5YR, 7.5YR

Value: 3 or 4 dry, 2.5 or 3 moist

Chroma: 2 or 3, dry or moist

Clay content: 50 to 60 percent

77—Lykorly gravelly loam, 1 to 4 percent slopes

Map Unit Setting

Landform: stream terraces

Elevation: 6,000 to 6,500 feet (1,829 to 1,981 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 52 to 54 degrees F (11 to 12 degrees C)

Mean annual soil temperature: 54 to 56 degrees F (13 to 14 degrees C)

Frost-free period: 130 to 160 days

Map Unit Composition

Lykorly and similar soils: 85 percent

Minor components: 15 percent

- Soils that are shallow to bedrock
- Soils that are deep to bedrock
- Soils that have accumulation of calcium carbonate in the profile
- Soils that have greater than 35 percent rock fragments in the profile
- Soils that have low amounts of clay in the profile

Properties and Qualities

Lykorly soils

Taxonomic classification: Fine-loamy, mixed, superactive, mesic Aridic Haplustalfs

Geomorphic position: broad drainageways

Parent material: alluvium

Slope: 1 to 4 percent

Drainage class: Well drained

Permeability: about 0.13 in/hr (slow)

Available water capacity total inches: 10.7

Shrink-swell potential: about 7.5 LEP (high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Hydrologic group: C

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Loamy Upland 13-17" p.z.

Ecosystem site number: 035XF605AZ

Present native vegetation: blue grama, Wyoming big sagebrush, western wheatgrass, Elymus elymoides ssp. elymoides, Hesperostipa comata ssp. comata, Indian ricegrass, Pleuraphis jamesii, fourwing saltbush, muttongrass

Land capability (nonirrigated): 6s

Taxonomic Unit Description

Type Location: Coconino County, Arizona; on the Hualapai Indian Reservation; 1,450 feet west and 2,875 feet south of the northeast corner of section 20, T. 29 N., R. 6 W.

A—0 to 1 inch; light brown (7.5YR 6/4) gravelly loam, brown (7.5YR 5/4) moist; weak thick platy structure; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine vesicular pores; 15 percent angular gravel; noneffervescent; slightly acid (pH 6.4); abrupt smooth boundary.

E—1 to 2 inches; light yellowish brown (10YR 6/4) loam, yellowish brown (10YR 5/4) moist; weak thick platy structure; slightly hard, very friable, sticky and

plastic; many very fine roots; many very fine vesicular pores; noneffervescent; slightly acid (pH 6.4); abrupt smooth boundary.

Bw—2 to 4 inches; dark yellowish brown (10YR 4/4) loam, dark yellowish brown (10YR 3/4) moist; weak fine subangular blocky structure parting to moderate fine granular; slightly hard, friable, sticky and plastic; many very fine roots; many very fine tubular pores; noneffervescent; slightly acid (pH 6.4); clear smooth boundary.

2Bt1—4 to 11 inches; dark yellowish brown (10YR 4/4) and brown (7.5YR 5/4) clay loam, dark yellowish brown (10YR 3/4) and dark brown (7.5YR 4/4) moist; moderate fine prismatic structure parting to moderate fine subangular blocky; hard, very firm, very sticky and very plastic; many very fine roots; many very fine tubular pores; common stress cutans and clay bridging sand grains; organic matter stains along planar voids; noneffervescent; slightly acid (pH 6.5); clear smooth boundary.

2Bt2—11 to 25 inches; dark yellowish brown (10YR 4/4) and brown (7.5YR 5/4) clay loam, dark yellowish brown (10YR 3/4) and dark brown (7.5YR 4/4) moist; weak medium prismatic structure parting to weak medium subangular blocky; hard, firm, sticky and plastic; common very fine roots; many very fine tubular pores; common clay bridges between sand grains and argillans on skeleton grains; noneffervescent; neutral (pH 7.0); clear smooth boundary.

2Btk—25 to 31 inches; brown (10YR 5/3) loam, dark brown (10YR 4/3) moist; weak medium subangular blocky structure; hard, firm, sticky and plastic; common very fine roots; many very fine tubular pores; clay bridging sand grains; strongly effervescent, 2 percent calcium carbonate equivalent; slightly alkaline (pH 7.4); clear smooth boundary.

3Bk—31 to 44 inches; brown (7.5YR 5/4) loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; hard, firm, sticky and plastic; common fine roots; many very fine tubular pores; few soft calcium carbonate accumulations; strongly effervescent, 1 percent calcium carbonate equivalent; moderately alkaline (pH 8.0); clear smooth boundary.

4Btkb—44 to 60 inches; yellowish red (5YR 5/6) clay, yellowish red (5YR 5/6) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; very hard, very firm, very sticky and very plastic; few fine roots; few fine tubular pores;

many stress cutans; argillans around skeleton grains; strongly effervescent, common fine soft calcium carbonate accumulations, 2 percent calcium carbonate equivalent; slightly alkaline (pH 7.8).

Range in Characteristics

Rock fragments: less than 5 percent in the control section

Calcium carbonate equivalent: less than 15 percent

A horizon

Hue: 7.5YR, 10YR

Value: 5 or 6 dry, 4 or 5 moist

Chroma: 3 or 4 dry or moist

Bt horizon(s)

Texture: loam, silt, clay loam

Reaction: slightly alkaline to moderately alkaline

Btk horizons

Hue: 10YR, 7.5YR

Value 4 through 6 dry, 3 or 4 moist

Chroma: 3 or 4, dry or moist

Sand content: averages less than 35 percent, with greater than 15 percent fine sand or coarser

Reaction: slightly acid to moderately alkaline

E, Bw and Btkb horizons do not occur in all pedons.

78—Lykorly loam, 2 to 4 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,990 to 7,480 feet (1,520 to 2,280 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)

Mean annual soil temperature: 50 to 54 degrees F (11 to 13 degrees C)

Frost-free period: 135 to 150 days

Map Unit Composition

Lykorly and similar soils: 90 percent

Minor components: 10 percent

- Soils that are shallow to bedrock
- Soils that are deep to bedrock
- Soils that have accumulation of calcium carbonate in the profile
- Soils that have greater than 35 percent rock fragments in the profile

- Soils that have low amounts of clay in the profile

Properties and Qualities

Lykorly soils

Taxonomic classification: Fine-loamy, mixed, superactive, mesic Aridic Haplustalfs

Geomorphic position: broad drainageways

Parent material: alluvium derived from limestone and sandstone

Slope: 2 to 4 percent

Surface fragments: about 2 percent coarse gravel

Drainage class: Well drained

Permeability: about 0.40 in/hr (moderately slow)

Available water capacity total inches: 10.0

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: Occasional

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Medium

Hydrologic group: C

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Loamy Upland 13-17" p.z.

Ecosystem site number: 035XF605AZ

Present native vegetation: Wyoming big sagebrush, blue grama, muttongrass, western wheatgrass, other evergreen trees

Land capability (nonirrigated): 6s

Taxonomic Unit Description

Type Location: On the Coconino Plateau; 4,998 feet southwest of Tusayan Ruins; 36 degrees, 0 minutes, 8 seconds north latitude; 111 degrees, 52 minutes, 14 seconds west longitude.

A1—0 to 4 inches; brown (10YR 4/3) loam; very dark brown (10YR 2/2) moist; strong medium and coarse subangular blocky structure; slightly hard, very friable, slightly sticky and moderately plastic; common very fine and fine roots; common very fine and fine tubular pores; noneffervescent; neutral (pH 6.8); clear smooth boundary.

A2—4 to 8 inches; brown (7.5YR 4/4) loam; dark brown (7.5YR 3/3) moist; moderate medium and coarse subangular blocky structure; soft, very friable, moderately sticky and moderately plastic; common very fine and fine roots; common very fine and fine tubular pores; noneffervescent; neutral (pH 7.0); clear smooth boundary.

Bw1—8 to 20 inches; brown (7.5YR 4/4) loam; dark brown (7.5YR 3/3) moist; moderate fine and medium subangular blocky structure; slightly hard, very friable; slightly sticky and slightly plastic; common very fine

and fine roots; common very fine and fine tubular pores; noneffervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bw2—20 to 31 inches; brown (7.5YR 4/4) loam; dark brown (7.5YR 3/3) moist; strong fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine tubular pores; noneffervescent; moderately alkaline (pH 8.4); clear smooth boundary.

2Btk1—31 to 40 inches; brown (7.5YR 4/4) silty clay loam; very dark brown (7.5YR 2.5/3) moist; strong medium and fine subangular blocky structure; slightly hard, very friable, moderately sticky and moderately plastic; common very fine and fine roots; common very fine and fine tubular pores; few faint clay films on faces of peds and lining pores; few fine filaments of calcium carbonate; strongly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

2Btk2—40 to 50 inches; dark brown (7.5YR 3/3) silty clay loam; very dark brown (7.5YR 2.5/3) moist; strong fine and medium subangular blocky structure; hard, very friable, moderately sticky and moderately plastic; common very fine and fine roots; common very fine and fine tubular pores; few faint clay films on faces of peds and lining pores; few fine filaments of calcium carbonate; 5 percent gravel; slightly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

3Ab—50 to 60 inches; dark brown (7.5YR 3/4) loam; very dark brown (7.5YR 2.5/3) moist; moderate fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine tubular pores; noneffervescent; moderately alkaline (pH 8.2).

Range in Characteristics

Rock fragments: less than 5 percent in the control section

Calcium carbonate equivalent: less than 15 percent

A horizon

Hue: 7.5YR, 10YR

Value: 4 through 6 dry, 2 through 5 moist

Chroma: 2 through 4, dry or moist

Btk horizons

Hue: 10YR, 7.5YR

Value 4 through 6 dry, 2.5 through 4 moist

Chroma: 3 or 4, dry or moist

Sand content: averages less than 35 percent, with greater than 15 percent fine sand or coarser

Reaction: slightly acid to moderately alkaline

79—Meadview-Arizo complex, 1 to 5 percent slopes

Map Unit Setting

Landform: flood plain

Elevation: 1,800 to 2,500 feet (548 to 762 meters)

Mean annual precipitation: 6 to 9 inches (152 to 229 millimeters)

Mean annual air temperature: 64 to 70 degrees F (18 to 21 degrees C)

Mean annual soil temperature: 66 to 72 degrees F (20 to 23 degrees C)

Frost-free period: 210 to 280 days

Map Unit Composition

Meadview and similar soils: 55 percent

Arizo and similar soils: 20 percent

Minor components: 25 percent

- Soils that have indurated hardpans
- Gypsil fine sandy loam, 2 to 25 percent slopes
- Soils that have cobbly or very cobbly loamy sand surface textures

Properties and Qualities

Meadview soils

Taxonomic classification: sandy-skeletal, mixed, thermic Durinodic Haplocalcids

Geomorphic position: stream terraces

Parent material: alluvium

Slope: 1 to 5 percent

Surface fragments: about 60 percent coarse gravel, about 5 percent cobbles, about 3 percent stones

Drainage class: Well drained

Permeability: about 0.13 in/hr (slow)

Available water capacity total inches: 2.1

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Medium

Hydrologic group: C

Major Land Resource Area: 30

Land Resource Unit: 30-2

Ecological site name: Limy Upland, Deep 6-9" p.z.

Ecosystem site number: 030XB215AZ

Present native vegetation: white bursage,

creosotebush, rayless goldenhead, Indian ricegrass, big galleta, flattop buckwheat
Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 1.43 miles northeast of Gyp Wash; 36 degrees, 14 minutes, 55 seconds north latitude; 113 degrees, 55 minutes, 25 seconds west longitude.

A—0 to 2 inches; reddish yellow (7.5YR 6/6) very gravelly sandy loam, strong brown (7.5YR 4/6) moist; weak thick platy structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; common very fine irregular and few fine tubular pores; 40 percent gravel; violently effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bk1—2 to 8 inches; reddish yellow (7.5YR 6/6) gravelly loam, strong brown (7.5YR 4/6) moist; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and few fine and medium roots; common very fine and few fine tubular pores; 25 percent gravel; thick coats and pendants of calcium carbonate on the sides and undersides of rock fragments; violently effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bk2—8 to 14 inches; reddish yellow (7.5YR 7/6) very gravelly loam, strong brown (7.5YR 5/6) moist; massive; slightly hard, very friable, moderately sticky and slightly plastic; few very fine roots; few very fine tubular pores; 55 percent gravel; thick coats of calcium carbonate on the sides and undersides of rock fragments; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bkq—14 to 60 inches; pink (7.5YR 7/4) extremely gravelly loamy coarse sand, strong brown (7.5YR 5/6) moist; massive; hard, brittle, nonsticky and nonplastic; few very fine roots; few very fine irregular pores; 50 percent gravel, 10 percent cobble, 10 percent stone, rock fragments are stratified and variable; common strongly silica cemented lenses; strongly effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Depth to calcic horizon: 2 to 18 inches

Depth to gravel and sand: 20 to 30 inches

Depth to brittle silica and calcium carbonate cemented materials: 14 to 40 inches

Calcium carbonate equivalent: 5 to 30 percent

Clay content: averages less than 10 percent in the control section

Rock fragments: average 35 to 75 percent gravel, cobble, and stone in the particle size control section

A horizon

Hue: 7.5YR, 10YR

Value: 5 through 7 dry, 4 or 5 moist

Chroma: 3 through 6, dry or moist

Bk and Bkq horizons

Hue: 7.5YR, 10YR

Value: 5 through 8 dry, 4 through 6 moist

Chroma: 3 through 6, dry or moist

Properties and Qualities

Arizo soils

Taxonomic classification: sandy-skeletal, mixed, thermic Typic Torriorthents

Geomorphic position: flood plains

Parent material: alluvium

Slope: 1 to 5 percent

Surface fragments: about 25 percent cobbles, about 55 percent coarse gravel, about 10 percent stones

Drainage class: Excessively drained

Permeability: about 19.98 in/hr (very rapid)

Available water capacity total inches: 1.2

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: Occasional

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Negligible

Hydrologic group: A

Major Land Resource Area: 30

Land Resource Unit: 30-2

Ecological site name: Sandy Wash 6-9" p.z.

Ecosystem site number: 030XB218AZ

Present native vegetation: white burrobrush, creosotebush, catclaw acacia, big galleta

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: in the Grand Wash; 3,345 feet east of Tassi Ranch; 36 degrees, 15 minutes, 1 second north latitude; 113 degrees, 55 minutes, 4 seconds west longitude.

A—0 to 3 inches; reddish yellow (7.5YR 6/6) extremely stony sand, brown (7.5YR 4/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and few medium roots; few very fine tubular and common very fine irregular pores; 40 percent gravel, 20 percent cobble,

25 percent stone; violently effervescent; moderately alkaline (pH 8.4); abrupt wavy boundary.

C—3 to 60 inches; strong brown (7.5YR 5/6) stratified extremely stony coarse sand to extremely gravelly loamy sand, strong brown (7.5YR 4/6) moist; single grain; loose, nonsticky and nonplastic; common very fine roots; few very fine tubular and common very fine and fine irregular pores; 60 percent gravel, 10 percent cobble, 10 percent stone; strongly effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Rock fragments: 35 to 85 percent in the particle size control section

A horizon

Hue: 7.5YR, 10YR

Value: 6 or 7 dry, 4 through 6 moist

Chroma: 4 through 6, dry or moist

C horizon

Hue: 7.5YR, 10YR

Value: 6 or 7 dry, 4 through 6 moist

Chroma: 4 through 6, dry or moist

Effervescence: strongly to violently effervescent, less than 10 percent calcium carbonate equivalent

80—Meriwhitica-Rock outcrop complex, 35 to 70 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,400 to 5,800 feet (1,645 to 1,767 meters)

Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)

Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)

Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)

Frost-free period: 135 to 150 days

Map Unit Composition

Meriwhitica and similar soils: 55 percent

Rock outcrop: 30 percent

Minor components: 15 percent

- Talus
- Rubbleland
- Soils more than 20 inches deep to bedrock that support a woodland plant community
- Soils on slopes greater than 70 percent
- Soils that have a very stony or very bouldery surface phase

Properties and Qualities

Meriwhitica soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, calcareous, mesic Lithic Ustic Torriorthents

Geomorphic position: pockets and ledges on ridges and plateau escarpments

Parent material: colluvium and/or residuum weathered from limestone

Slope: 35 to 70 percent

Surface fragments: about 15 percent coarse gravel, about 30 percent cobbles, about 5 percent stones

Depth to restrictive feature: 14 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 1.5

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Sedimentary Cliffs 10-14" p.z.

Ecosystem site number: 035XC302AZ

Present native vegetation: other evergreen trees, pointleaf manzanita, turbinella oak, Wyoming big sagebrush, skunkbush sumac, spiny greasewood

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In Whitmore Canyon; 258 feet southwest of Paws Pocket; 36 degrees, 12 minutes, 57 seconds north latitude; 113 degrees, 13 minutes, 2 seconds west longitude.

A—0 to 3 inches; brown (7.5YR 5/3) very cobbly fine sandy loam; dark brown (7.5YR 3/3) moist; moderate fine subangular blocky structure parting to granular; soft, very friable, slightly sticky and slightly plastic, many very fine roots; common very fine interstitial pores; 15 percent gravel, 30 percent cobble, 5 percent stone; strongly effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bk1—3 to 12 inches; light brown (7.5YR 6/4) very cobbly fine sandy loam; brown (7.5YR 4/4) moist; moderate fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine and few fine and medium roots; common very

fine and few fine irregular and tubular pores; 15 percent gravel, 30 percent cobble, 5 percent stone; violently effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bk2—12 to 16 inches; light brown (7.5YR 6/4) very cobbly fine sandy loam; brown (7.5YR 5/4) moist; moderate fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine and few fine and medium roots; common very fine and few fine irregular and tubular pores; 15 percent gravel, 30 percent cobble, 5 percent stone; violently effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

R—16 inches; limestone bedrock.

Range in Characteristics

gravey.

Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)

Frost-free period: 150 to 175 days

Map Unit Composition

Meriwhitica and similar soils: 60 percent

Tassi and similar soils: 30 percent

Minor components: 10 percent

- Rock outcrop
- Soils on very steep side slopes of canyons
- Soils that are occasionally flooded in canyon bottoms
- Soils greater than 10 inches deep with an argillic and/or calcic horizon

Properties and Qualities

Meriwhitica soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, calcareous, mesic Lithic Ustic Torriorthents

Geomorphic position: side slopes of canyons

Parent material: sandy colluvium derived from calcareous sandstone

Slope: 11 to 33 percent

Surface fragments: about 15 percent subrounded cobbles, about 55 percent medium subangular gravel

Depth to restrictive feature: 6 to 20 inches to bedrock (lithic); 4 to 19 inches to bedrock (paralithic)

Drainage class: Somewhat excessively drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 1.0

Shrink-swell potential: about 1.5 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Limestone Hills 10-14" p.z.

Ecosystem site number: 035XC308AZ

Present native vegetation: muttongrass, Wyoming big sagebrush, blue grama, Stansbury cliffrose, Utah juniper, green Mormon tea

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Marble Platform; 6.04 miles west of Pillow Mountain; 36 degrees, 15 minutes, 1 second north latitude; 111 degrees, 46 minutes, 17 seconds west longitude.

BA—0 to 1 inches; brown (7.5YR 5/4) extremely gravelly fine sandy loam, dark brown (7.5YR 3/4) moist; weak fine granular structure; loose, nonsticky and nonplastic; very few very fine roots; no pores; strongly effervescent; 55 percent gravel, 15 percent cobble; moderately alkaline (pH 8.2); clear smooth boundary.

Bk1—1 to 8 inches; brown (7.5YR 5/4) gravelly fine sandy loam, dark brown (7.5YR 3/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and very few medium roots; very few very fine irregular pores; strongly effervescent; 20 percent gravel, 5 percent cobble; moderately alkaline (pH 8.2); clear smooth boundary.

Bk2—8 to 13 inches; brown (7.5YR 5/4) extremely cobbly very fine sandy loam, dark brown (7.5YR 3/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine irregular pores; violently effervescent; 20 percent gravel, 50 percent cobble; strongly alkaline (pH 8.6); clear smooth boundary.

Bk3—13 to 18 inches; pale brown (10YR 6/3) extremely cobbly very fine sandy loam, yellowish brown (10YR 5/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; very few very fine roots; common fine irregular pores; violently effervescent; 20 percent gravel, 50 percent cobble; strongly alkaline (pH 8.6); very abrupt smooth boundary.

2Cr—18 to 20 inches; very pale brown (10YR 7/3) weathered sandstone, pale brown (10YR 6/3) moist; very abrupt smooth boundary.

2R—20 inches; sandstone of the Kaibab formation.

Range in Characteristics

Depth to bedrock: 6 to 20 inches

Organic matter content: 0.1 to 0.5 percent

Clay content: averages 2 to 7 percent

Rock fragments: average 35 to 75 percent gravel, cobble, and stone

A horizon

Hue: 7.5YR, 10YR

Value: 5 or 6 dry, 3 through 5 moist

Chroma: 3 or 4, dry or moist

Calcium carbonate equivalent: 5 to 20 percent

Bk horizons

Hue: 7.5YR, 10YR

Value: 5 or 6 dry, 3 through 5 moist
 Calcium carbonate equivalent: 15 to 25 percent

Tassi soils

Taxonomic classification: Loamy-skeletal, mixed, active, mesic, shallow Ustic Petrocalcids
Geomorphic position: summits of plateau remnants
Parent material: sandy alluvium derived from calcareous sandstone and/or sandy colluvium derived from calcareous sandstone
Slope: 0 to 5 percent
Surface fragments: about 5 percent medium subrounded gravel
Depth to restrictive feature: 13 to 40 inches to bedrock (lithic); 5 to 20 inches to petrocalcic
Drainage class: Somewhat excessively drained
Permeability: about 4.00 in/hr (moderately rapid)
Available water capacity total inches: 0.8
Shrink-swell potential: about 1.5 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: Medium
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-3
Ecological site name: Shallow Loamy 10-14" p.z.
Ecosystem site number: 035XC319AZ
Present native vegetation: Wyoming big sagebrush, blue grama, galleta, ephedra, bottlebrush squirreltail
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Marble Platform; 2.84 miles west of Shinumo Alter; 36 degrees, 26 minutes, 5 seconds north latitude; 111 degrees, 46 seconds, 17 minutes west longitude.

AC—0 to 1 inch; dark brown (7.5YR 3/4) very fine sandy loam, brown (7.5YR 4/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; very few very fine roots; no pores; strongly effervescent; 5 percent gravel; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bw1—1 to 5 inches; dark brown (7.5YR 3/4) gravelly very fine sandy loam, brown (7.5YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; few fine irregular pores; strongly effervescent; 30 percent gravel; moderately alkaline (pH 8.2); clear smooth boundary.

Bw2—5 to 11 inches; dark brown (7.5YR 3/4) extremely cobbly very fine sandy loam, brown (7.5YR 4/4) moist; massive; soft, very friable, nonsticky and

nonplastic; few very fine and very few medium roots; few very fine irregular pores; strongly effervescent; 30 percent gravel, 40 percent cobble; moderately alkaline (pH 8.2); very abrupt smooth boundary.

2Bkm—11 to 13 inches; pinkish white (7.5YR 8/2) indurated petrocalcic, pinkish white (7.5YR 8/2) moist; very thick platy structure; violently effervescent; very abrupt smooth boundary.

3R—13 inches; sandstone of the Kaibab formation.

Range in Characteristics

This soil is a taxadjunct to the Tassi series. The Tassi series classifies as a Loamy, mixed, mesic, shallow Ustic Petrocalcids. This soil has more than 35 percent coarse fragments in the particle size control section, and the cation-exchange activity class is active.

82—Metuck family-Rock outcrop complex, 8 to 50 percent slopes

Map Unit Setting

Landform: plateau
Elevation: 5,000 to 7,500 feet (1,524 to 2,286 meters)
Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)
Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)
Mean annual soil temperature: 50 to 54 degrees F (11 to 13 degrees C)
Frost-free period: 135 to 150 days

Map Unit Composition

Metuck family and similar soils: 55 percent
 Rock outcrop: 30 percent
 Minor components: 15 percent

- Soils that have accumulation of calcium carbonate in the profile
- Soils that have accumulation of clay in the profile
- Soils that are moderately deep or deep to bedrock
- Talus slopes devoid of vegetation

Properties and Qualities

Metuck family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, calcareous, mesic Aridic Lithic Ustorthents
Geomorphic position: ledges of pediments
Parent material: colluvium derived from sandstone and siltstone and/or residuum weathered from sandstone and siltstone

Slope: 8 to 50 percent

Surface fragments: about 30 percent cobbles, about 30 percent coarse gravel, about 5 percent stones

Depth to restrictive feature: 4 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 0.8

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Sedimentary Cliffs 13-17" p.z.

Ecosystem site number: 035XF601AZ

Present native vegetation: littleleaf mountain-mahogany, turbinella oak, other evergreen trees, pointleaf manzanita, desert needlegrass

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In Chuar Valley; 1,963 feet south of Saddle Mountain; 36 degrees, 18 minutes, 25 seconds north latitude; 111 degrees, 56 minutes, 55 seconds west longitude.

A—0 to 2 inches; red (2.5YR 4/6) extremely cobbly loam; dark red (2.5YR 3/6) moist; weak fine subangular blocky structure; soft, very friable, moderately sticky and moderately plastic; common fine and medium and few coarse roots; many very fine irregular and common fine tubular pores; 25 percent gravel, 30 percent cobble, 5 percent stone, and 5 percent boulder; strongly effervescent; strongly alkaline (pH 8.6); abrupt smooth boundary.

Bw—2 to 8 inches; red (2.5YR 4/6) extremely cobbly loam; dark red (2.5YR 3/6) moist; weak medium subangular blocky structure; soft, very friable, moderately sticky and moderately plastic; common fine and medium and few coarse roots; common fine through coarse tubular pores; 25 percent channers; 10 percent gravel, 30 percent cobble, 5 percent stone, and 5 percent boulder; strongly effervescent; strongly alkaline (pH 8.6); clear wavy boundary.

Crk—8 to 16 inches; red (2.5YR 4/6) extremely cobbly loam; dark red (2.5YR 3/6) moist; massive; few fine through coarse roots; many fine through coarse tubular

pores; common coarse soft masses of calcium carbonate; 45 percent gravel, 10 percent cobble, and 10 percent stone; violently effervescent; strongly alkaline (pH 8.6); abrupt irregular boundary.

R—16 inches; hard sandstone bedrock.

Range in Characteristics

Depth to bedrock: 4 to 20 inches, but is commonly less than 10 inches

Rock fragments: 35 to 50 percent

Clay content: averages 10 to 15 percent

Calcium carbonate equivalent: 0 to 10 percent

A horizon

Value: 4 or 5 dry, 3 or 4 moist

Chroma: 4 or 6, dry or moist

Bw horizon

Value: 4 or 5 dry, 3 or 4 moist

A Bk horizon less than 6 inches thick is present in some pedons.

Rock outcrop

Ledges and escarpments of sandstone and mudstone of the Supai Group

83—Natank-Disterheff-Yumtheska complex, 2 to 35 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 6,200 to 6,600 feet (1,890 to 2,012 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 46 to 54 degrees F (8 to 12 degrees C)

Mean annual soil temperature: 48 to 56 degrees F (10 to 14 degrees C)

Frost-free period: 130 to 160 days

Map Unit Composition

Natank and similar soils: 40 percent

Disterheff and similar soils: 30 percent

Yumtheska and similar soils: 15 percent

Minor components: 15 percent

- Rock outcrop
- Bilburc soils
- Soils that have a cobbly surface phase

- Soils that have strongly cemented hardpans
- Soils that do not have calcium carbonate accumulations

Properties and Qualities

Natank soils

Taxonomic classification: Fine, smectitic, mesic
Calcic Haplustalfs

Geomorphic position: summits and side slopes of low
hills and ridges

Parent material: residuum weathered from limestone
and sandstone

Slope: 2 to 15 percent

Surface fragments: about 70 percent gravel

Bt Horizons

Hue: 5YR, 7.5YR
 Value: 3 or 4, dry or moist
 Chroma: 3 or 4 dry, 2 or 3 moist

Btk or Bk horizons

Hue: 7.5YR, 5YR
 Value: 4 or 5 dry, 3 or 4 moist
 Chroma: 4 through 6, dry or moist
 Calcium carbonate equivalent: averages 15 to 40 percent in the calcic horizon

Disterheff soils

Taxonomic classification: Fine, smectitic, mesic Vertic Haplustalfs

Geomorphic position: summits

Parent material: residuum weathered from limestone and sandstone

Slope: 2 to 8 percent

Surface fragments: about 45 percent gravel

Drainage class: Well drained

Permeability: about 0.13 in/hr (slow)

Available water capacity total inches: 8.7

Shrink-swell potential: about 7.5 LEP (high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Hydrologic group: C

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Clay Loam Upland 13-17" P.z.

Ecosystem site number: 035XF603AZ

Present native vegetation: blue grama, western wheatgrass, Wyoming big sagebrush, muttongrass, Elymus elymoides ssp. elymoides, Pleuraphis jamesii, Utah juniper, prairie Junegrass

Land capability (nonirrigated): 6c

Taxonomic Unit Description

A—0 to 2 inches; brown (10YR 5/3) very gravelly loam; 40 percent gravel; noneffervescent; neutral (pH 7.0).

Bt—2 to 23 inches; reddish brown (5YR 4/4) clay; 5 percent gravel; slightly effervescent; slightly alkaline (pH 7.4).

Btk—23 to 39 inches; pink (5YR 7/3) gravelly clay loam; 25 percent gravel; violently effervescent; moderately alkaline (pH 8.2).

Bk—39 to 60 inches; pink (5YR 8/4) clay loam; 5 percent gravel; violently effervescent, moderately alkaline (pH 8.4).

Range in Characteristics

Depth to calcic horizon: 17 to 30 inches
 Depth to bedrock: greater than 60 inches
 Clay content: 40 to 50 percent in the particle size control section

Rock fragments: 5 to 50 percent gravel; average less than 35 percent in the particle size control section

A horizon

Hue: 7.5YR, 10YR
 Value: 3 through 5 dry, 3 or 4 moist
 Chroma: 2 through 4, dry or moist

Bt horizon(s)

Hue: 2.5YR, 5YR, 7.5YR
 Value: 3 or 4, dry or moist
 Chroma: 3 through 6, dry or moist
 Reaction: neutral to moderately alkaline (pH 6.6 to 8.4)

Btk horizon(s)

Hue: 2.5YR, 5YR, 7.5YR
 Value: 4 through 8 dry, 5 or 6 moist
 Chroma: 2 through 6 dry, 3 through 6 moist
 Calcium carbonate equivalent: 10 to 15 percent

Bk horizon

Hue: 2.5YR, 5YR, 7.5YR
 Value: 4 through 8 dry, 5 or 6 moist
 Chroma: 2 through 6 dry, 3 through 6 moist
 Calcium carbonate equivalent: 10 to 40 percent

Yumtheska soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Calciustolls

Geomorphic position: shoulders and sideslopes of hills and ridges

Parent material: residuum weathered from limestone and sandstone

Slope: 3 to 35 percent

Depth to restrictive feature: 7 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 1.4

Shrink-swell potential: about 1.5 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Limestone Upland (JUOS, PIED)
13-17" p.z.

Ecosystem site number: 035XF619AZ

Present native vegetation: muttongrass, Stansbury cliffrose, blue grama, Wyoming big sagebrush, Elymus elymoides ssp. elymoides, Freemont's mahonia

Land capability (nonirrigated): 6c

Taxonomic Unit Description

A—0 to 1 inch; brown (10YR 4/3) very cobbly loam; 10 percent gravel, 30 percent cobble, and 10 percent stone; strongly effervescent; moderately alkaline (pH 8.2).

Bk—1 to 14 inches; grayish brown (10YR 5/2) very cobbly loam; 5 percent gravel, 35 percent cobble, and 10 percent stone; violently effervescent; moderately alkaline (pH 8.4).

R—14 inches; limestone bedrock.

Range in Characteristics

Rock fragments: average more than 35 percent in the particle size control section

Clay content: averages 18 to 25 percent in the particle size control section

Depth to bedrock: 7 to 20 inches

A horizon

Hue: 7.5YR, 10YR

Value: 3 through 5, dry or moist

Chroma: 2 through 4 dry, 2 or 3 moist

Organic matter: averages 1 to 5 percent in the surface

Bk horizon(s)

Hue: 7.5YR, 10YR

Value: 3 through 7 dry, 3 through 5 moist

Chroma: 2 through 4, dry or moist

Calcium carbonate equivalent: 15 to 40 percent

84—Natank-Yumtheska complex, 2 to 8 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,900 to 6,100 feet (1,798 to 1,860 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 48 to 54 degrees F (9 to 12 degrees C)

Mean annual soil temperature: 50 to 56 degrees F (11 to 14 degrees C)

Frost-free period: 135 to 150 days

Map Unit Composition

Natank and similar soils: 45 percent

Yumtheska and similar soils: 45 percent

Minor components: 10 percent

- Rock outcrop
- Clayey soils on toeslopes that are greater than 60 inches to bedrock
- Very deep loamy soils in drainageways that are subject to occasional flooding
- Soils that have a nongravelly sandy loam surface phase
- Soils that have steeper slopes on toeslopes adjacent to drainageways
- Soils that have hardpans

Properties and Qualities

Natank soils

Taxonomic classification: Fine, smectitic, mesic
Calcic Haplustalfs

Geomorphic position: summits and side slopes of low hills and ridges

Parent material: alluvium and/or residuum weathered from cherty limestone

Slope: 2 to 8 percent

Surface fragments: about 50 percent coarse gravel

Depth to restrictive feature: 23 to 39 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.01 in/hr (very slow)

Available water capacity total inches: 4.6

Shrink-swell potential: about 7.0 LEP (high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: High

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Limestone Upland (JUOS, PIED)
13-17" p.z.

Ecosystem site number: 035XF619AZ

Present native vegetation: Artemisia, Utah juniper, Colorado pinyon, Stansbury cliffrose, green Mormon tea

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Shivwits Plateau; 3,579 feet north of Kelly Point, 35 degrees, 50 minutes, 38 seconds north latitude; 113 degrees, 28 minutes, 6 seconds west longitude.

A1—0 to 1 inch; reddish brown (5YR 4/4) very gravelly silty clay loam; dark reddish brown (5YR 3/4) moist; weak very fine and fine granular structure; soft, very friable, moderately sticky and moderately plastic; few very fine roots; common very fine irregular and tubular pores; 50 percent gravel; noneffervescent; slightly alkaline (pH 7.6); abrupt smooth boundary.

A2—1 to 3 inches; reddish brown (5YR 4/3) silty clay; dark reddish brown (5YR 3/4) moist; moderate very fine and fine granular structure; soft, very friable, very sticky and very plastic; few very fine roots; many very fine irregular and tubular pores; 5 percent gravel; noneffervescent; slightly alkaline (pH 7.6); clear wavy boundary.

Bt—3 to 9 inches; reddish brown (5YR 4/4) clay; dark reddish brown (5YR 3/4) moist; weak medium prismatic structure parting to strong fine subangular blocky; hard, firm, very sticky and very plastic; many fine and medium and few coarse roots; common very fine and fine tubular pores; many faint clay films on faces of peds; noneffervescent; slightly alkaline (pH 7.4); clear wavy boundary.

Btk1—9 to 17 inches; reddish brown (5YR 4/4) clay; dark reddish brown (5YR 3/4) moist; strong medium prismatic structure parting to strong fine angular blocky; very hard, very firm, very sticky and very plastic; few fine and medium roots in cracks; few fine tubular pores; many faint clay films on faces of peds; few fine soft slightly effervescent masses of calcium carbonate; matrix is noneffervescent; slightly alkaline (pH 7.6); clear wavy boundary.

Btk2—17 to 31 inches; reddish brown (5YR 4/4) clay; dark reddish brown (5YR 3/4) moist; strong coarse prismatic structure parting to strong fine angular blocky; very hard, very firm, very sticky and very plastic; few fine and medium roots in cracks; few fine tubular pores; many faint clay films on faces of peds; common fine soft masses of calcium carbonate; slightly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

R—31 inches; limestone bedrock.

Range in Characteristics

Depth to calcic horizon: 14 to 31 inches

Depth to bedrock: 23 to 39 inches

Clay content: 40 to 55 percent in the particle size control section

Rock fragments: average less than 15 percent in the particle size control section

A horizons

Hue: 5YR, 7.5YR, 10YR

Value: 3 through 5, dry or moist
Chroma: 2 through 4, dry or moist
Organic matter: 1 to 2 percent

Bt horizons

Hue: 5YR, 7.5YR
Value: 3 or 4, dry or moist
Chroma: 3 or 4, dry or moist

Btk or Bk horizons

Hue: 7.5YR, 5YR
Value: 4 or 5 dry, 3 or 4 moist
Chroma: 4 through 6, dry or moist
Calcium carbonate equivalent: averages 15 to 40 percent in the calcic horizon

Yumtheska soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Calciustolls
Geomorphic position: shoulders of low hills and ridges
Parent material: colluvium derived from cherty limestone and/or residuum weathered from cherty limestone
Slope: 2 to 8 percent
Surface fragments: about 55 percent coarse gravel, about 5 percent cobbles
Depth to restrictive feature: 11 to 17 inches to bedrock (lithic)
Drainage class: Well drained
Permeability: about 1.30 in/hr (moderate)
Available water capacity total inches: 1.5
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: High
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-6
Ecological site name: Limestone Upland (JUOS, PIED) 13-17" p.z.

Ecosystem site number: 035XF619AZ

Present native vegetation: Artemisia, Utah juniper, Colorado pinyon, Stansbury cliffrose, green Mormon tea

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Shivwits Plateau, 3,063 feet north of Kelly Point, 35 degrees, 50 minutes, 34 seconds north latitude; 113 degrees, 28 minutes, 13 seconds west longitude.

A—0 to 1 inch; pale brown (10YR 6/3) gravelly loam; dark yellowish brown (10YR 3/4) moist; moderate thin

platy structure; soft, very friable, slightly sticky and moderately plastic; few very fine roots; many very fine irregular and tubular pores; 25 percent gravel; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bk1—1 to 4 inches; brown (7.5YR 5/3) gravelly loam; dark brown (7.5YR 3/3) moist; moderate medium subangular blocky structure; soft, very friable, slightly sticky and moderately plastic; common very fine and few fine through coarse roots; common very fine and few fine tubular pores; 15 percent gravel; few fine soft masses of calcium carbonate; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bk2—4 to 17 inches; brown (7.5YR 5/3) extremely gravelly loam; dark brown (7.5YR 3/3) moist; weak coarse subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine and few coarse roots; few very fine and fine tubular pores; 40 percent gravel sized pan fragments, 20 percent limestone cobble; many moderately thick calcium carbonate pendants; violently effervescent; moderately alkaline (pH 8.2); clear wavy boundary.

R—17 inches; limestone bedrock.

Range in Characteristics

Depth to calcic horizon: 5 to 10 inches

Depth to bedrock: 11 to 17 inches

Clay content: averages 15 to 18 percent in the particle size control section

Rock fragments: average more than 35 percent in the particle size control section

Calcium carbonate equivalent: 15 to 40 percent

Reaction: slightly alkaline to moderately alkaline

A horizon

Hue: 7.5YR, 10YR

Value: 4 through 6 dry, 3 or 4 moist

Chroma: 2 or 3, dry or moist

Reaction: slightly alkaline to moderately alkaline

Organic matter: 1 to 5 percent

Bk horizons

Hue: 7.5YR, 10YR

Value: 4 or 5 dry, 3 or 4 moist

Chroma: 2 or 3, dry or moist

85—Nutter-Gypocket complex, 2 to 20 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,000 to 4,100 feet (1,219 to 1,250 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 55 to 57 degrees F (13 to 14 degrees C)

Mean annual soil temperature: 57 to 59 degrees F (15 to 16 degrees C)

Frost-free period: 180 to 195 days

Map Unit Composition

Nutter and similar soils: 45 percent

Gypocket and similar soils: 40 percent

Minor components: 15 percent

- Soils in drainageways that are subject to occasional flooding
- Gypocket soils that have a rare flooding hazard
- Nutter soils that have a very gravelly fine sandy loam or gravelly sandy loam surface textures

Properties and Qualities

Nutter soils

Taxonomic classification: Loamy-skeletal, gypsic, mesic Typic Calcigypsid

Geomorphic position: fan skirt

Parent material: alluvium

Slope: 2 to 20 percent

Surface fragments: about 40 percent coarse gravel

Drainage class: Somewhat excessively drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 4.5

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Low

Hydrologic group: C

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Loamy Upland, Gypsiferous 6-10" p.z.

Ecosystem site number: 035XE518AZ

Present native vegetation: galleta, ephedra, gyp dropseed, winterfat, burrgrass, fourwing saltbush

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: about 300 feet south and 700 feet west of the northeast corner of section 22, township 40 north, range 10 west; 36 degrees, 51 minutes, 36.1 seconds north latitude; 113 degrees, 21 minutes, 49 seconds west longitude.

A—0 to 2 inches; light brown (7.5YR 6/4) very gravelly loam, brown (7.5YR 4/4) moist; weak thin platy

structure; slightly hard, friable, slightly sticky and nonplastic; many very fine and fine roots; many very fine irregular and common fine tubular pores; 40 percent gravel; slightly effervescent, 15 percent calcium carbonate equivalent; moderately alkaline (pH 8.2); clear smooth boundary.

Bk—2 to 13 inches; light brown (7.5YR 6/4) very gravelly loam, brown (7.5YR 4/4) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; common fine and very fine tubular and irregular pores; 35 percent gravel; violently effervescent, few fine irregular calcium carbonate masses, seams and coatings on rock fragments, 27 percent calcium carbonate equivalent; moderately alkaline (pH 8.2); clear smooth boundary.

Bky—13 to 23 inches; light brown (7.5YR 6/4), gravelly fine sandy loam, strong brown (7.5YR 5/6) moist; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine and fine roots; common fine and very fine tubular and irregular pores; 30 percent gravel; violently effervescent, few fine irregular calcium carbonate masses, seams and coatings on rock fragments, 29 percent calcium carbonate equivalent; 20 percent crystalline gypsum occurring as sand grains and pendants on rock fragments; moderately alkaline (pH 8.2); clear smooth boundary.

By1—23 to 38 inches; pink (7.5YR 7/4), very gravelly sandy loam, brown (7.5YR 5/4) moist; massive; soft, very friable, nonsticky and nonplastic; many very fine and common fine roots; common fine and very fine tubular pores; 50 percent gravel; strongly effervescent, 31 percent calcium carbonate equivalent; 55 percent crystalline gypsum occurring as sand grains and pendants and bridges on rock fragments; slightly alkaline (pH 7.8); clear smooth boundary.

By2—38 to 47 inches; reddish yellow (7.5YR 8/6), very gravelly coarse sandy loam, reddish yellow (7.5YR 6/6) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; few fine and very fine tubular pores; 45 percent gravel; strongly effervescent, 30 percent calcium carbonate equivalent; 35 percent crystalline gypsum occurring as sand grains and pendants on rock fragments; slightly alkaline (pH 7.6); abrupt smooth boundary.

By3—47 to 65 inches; pink (7.5YR 7/4), very gravelly loamy coarse sand, light brown (7.5YR 6/4) moist; single grain; loose; no roots; many very fine irregular

pores; 50 percent gravel; slightly effervescent, 31 percent calcium carbonate equivalent; 50 percent crystalline gypsum occurring as sand grains and pendants on rock fragments; slightly alkaline (pH 7.6).

Range in Characteristics

Depth to calcic horizon: 1 to 3 inches
Depth to gypsic horizon: 15 to 25 inches
Rock fragments: average 35 to 80 percent

A horizon

Hue: 5YR, 7.5YR
Value: 5 through 7 dry, 4 through 6 moist
Chroma: 4 through 6, dry or moist
Calcium carbonate equivalent: 5 to 25 percent

Bk horizon

Hue: 5YR, 7.5YR
Value: 5 through 8 dry, 4 through 8 moist
Chroma: 2 through 6, dry or moist
Gypsum: 0 to 15 percent
Calcium carbonate equivalent: 15 to 35 percent

By horizon

Hue: 7.5YR, 10YR
Value: 6 through 8 dry, 5 through 8 moist
Chroma: 0 through 6, dry or moist
Gypsum: 20 to 95 percent
Calcium carbonate equivalent: 10 to 35 percent

Gypocket soils

Taxonomic classification: sandy-skeletal, gypsic, mesic Typic Calcigypsis
Geomorphic position: fan skirt
Parent material: residuum weathered from gypsum
Slope: 2 to 20 percent
Surface fragments: about 50 percent coarse gravel
Drainage class: Excessively drained
Permeability: about 4.00 in/hr (moderately rapid)
Available water capacity total inches: 2.5
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: Low
Hydrologic group: C
Major Land Resource Area: 35
Land Resource Unit: 35-5
Ecological site name: Loamy Upland, Gypsiferous 6-10" p.z.
Ecosystem site number: 035XE518AZ

Present native vegetation: galleta, ephedra, gyp dropseed, winterfat, burrograss, fourwing saltbush
Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: about 400 feet north and 1,900 feet east of the southwest corner of section 36, township 40 north, range 10 west; 36 degrees, 49 minutes, 6.9 seconds north latitude; 113 degrees, 19 minutes, 4.4 seconds west longitude.

A—0 to 2 inches; pink (7.5YR 7/4) very gravelly fine sandy loam, brown (7.5YR 5/4) moist; weak thin platy structure; slightly hard, very friable, nonsticky and nonplastic; many fine and very fine roots; many very fine irregular and few fine and very fine tubular pores; 50 percent gravel and few cobble; strongly effervescent as disseminated calcium carbonate, 29 percent calcium carbonate equivalent; moderately alkaline (pH 8.2); clear smooth boundary.

Bk—2 to 14 inches; pink (7.5YR 7/4) very gravelly sandy loam, brown (7.5YR 5/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many fine and very fine roots; common fine and very fine tubular and irregular pores; 50 percent gravel and few cobble; strongly effervescent with calcium carbonate segregated as common fine pendants on rock fragments, 36 percent calcium carbonate equivalent; 5 percent crystalline gypsum; moderately alkaline (pH 8.4); clear smooth boundary.

By1—14 to 32 inches; very pale brown and white (10YR 8/3 and N 8/0), extremely gravelly loamy coarse sand, yellow and white (10YR 7/6 and N 8/) moist; single grain; slightly hard, very friable, nonsticky and nonplastic; many fine and very fine, and few medium roots; many fine and very fine irregular pores; 70 percent gravel; strongly effervescent as disseminated calcium carbonate, 29 percent calcium carbonate equivalent; 80 percent crystalline gypsum as pendants on rock fragments and sand grains; slightly alkaline (pH 7.6); abrupt smooth boundary.

By2—32 to 36 inches; very pale brown (10YR 8/3), extremely gravelly loamy sand, yellow (10YR 7/6) moist; single grain; slightly hard, very friable, nonsticky and nonplastic; common fine and very fine roots; many fine and very fine irregular pores; 60 percent gravel and 10 percent cobble; strongly effervescent as disseminated calcium carbonate, 19 percent calcium carbonate equivalent; 55 percent crystalline gypsum as pendants on rock fragments and sand grains; slightly alkaline (pH 7.6); abrupt smooth boundary.

By3—36 to 49 inches; very pale brown (10YR 8/3), extremely gravelly loamy coarse sand, brownish yellow (10YR 6/6) moist; single grain; slightly hard, very friable, nonsticky and nonplastic; few fine and very fine roots; many fine and very fine irregular pores; 65 percent gravel; strongly effervescent, 26 percent calcium carbonate equivalent; 50 percent crystalline gypsum as pendants on rock fragments and sand grains; slightly alkaline (pH 7.6); abrupt smooth boundary.

By4—49 to 59 inches; very pale brown (10YR 8/4), extremely cobbly loamy coarse sand, very pale brown (10YR 7/4) moist; single grain; slightly hard, very friable, nonsticky and nonplastic; few fine and very fine roots; many fine and very fine irregular pores; 50 percent gravel and 30 percent cobble; strongly effervescent, 28 percent calcium carbonate equivalent; 40 percent crystalline gypsum as pendants on rock fragments and sand grains; slightly alkaline (pH 7.6); abrupt smooth boundary.

By5—59 to 65 inches; very pale brown (10YR 8/4), very gravelly coarse sand, yellow (10YR 7/6) moist; single grain; slightly hard, very friable, nonsticky and nonplastic; no roots; many fine and very fine irregular pores; 40 percent gravel; strongly effervescent, 28 percent calcium carbonate equivalent; 15 percent crystalline gypsum as pendants on rock fragments and sand grains; slightly alkaline (pH 7.6).

Range in Characteristics

Depth to calcic horizon: 1 to 3 inches
 Depth to gypsic horizon: 10 to 25 inches
 Rock fragments: average 35 to 85 percent

A horizon

Hue: 7.5YR, 10YR
 Value: 6 through 8 dry, 4 through 6 moist
 Chroma: 4 through 6, dry or moist
 Effervescence: strongly to violently effervescent
 Calcium carbonate equivalent: 5 to 30 percent

Bk horizon

Hue: 7.5YR, 10YR
 Value: 6 through 8 dry, 4 through 6 moist
 Chroma: 4 through 6, dry or moist
 Gypsum: 0 to 15 percent
 Calcium carbonate equivalent: 15 to 38 percent

By horizon

Hue: 7.5YR, 10YR
 Value: 6 through 8 dry, 5 through 8 moist

Chroma: 0 through 6, dry or moist
 Gypsum: 15 to 95 percent
 Calcium carbonate equivalent: 5 to 30 percent

86—Orrubo very gravelly loam, 15 to 35 percent slopes

Map Unit Setting

Landform: fan terrace
Elevation: 1,400 to 2,200 feet (426 to 670 meters)
Mean annual precipitation: 6 to 9 inches (152 to 229 millimeters)
Mean annual air temperature: 64 to 70 degrees F (18 to 21 degrees C)
Mean annual soil temperature: 66 to 72 degrees F (20 to 23 degrees C)
Frost-free period: 230 to 280 days

Map Unit Composition

Orrubo and similar soils: 80 percent
 Minor components: 20 percent

- Rock outcrop
- Arizo soils in drainageways that are subject to occasional flooding
- Outcrops of gypsum bearing lacustrine sediments
- Soils that are moderately deep to a hardpan

Properties and Qualities

Orrubo soils

Taxonomic classification: Loamy-skeletal, carbonatic, thermic, shallow Calcic Petrocalcids
Geomorphic position: summits and sideslopes
Parent material: colluvium and/or residuum weathered from calcareous fanglomerate
Slope: 15 to 35 percent
Surface fragments: about 45 percent medium gravel
Depth to restrictive feature: 17 to 30 inches to bedrock (paralithic); 8 to 20 inches to petrocalcic
Drainage class: Well drained
Permeability: about 1.30 in/hr (moderate)
Available water capacity total inches: 1.6 inches
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: very high
Hydrologic group: D
Major Land Resource Area: 30
Land Resource Unit: 30-2
Ecological site name: Limy Slopes 6-9" p.z.
Ecosystem site number: 030XB212AZ
Present native vegetation: white bursage, creosotebush, Torrey Mormon tea, white ratany

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 3,543 feet northeast of Garden Wash; 36 degrees, 17 minutes, 15 seconds north latitude; 113 degrees, 57 minutes, 25 seconds west longitude.

A—0 to 2 inches; brown (7.5YR 5/4) very gravelly loam, brown (7.5YR 4/4) moist; weak fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine roots; common very fine and few fine tubular pores; violently effervescent; 45 percent calcium carbonate equivalent; 50 percent gravel; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bk1—2 to 7 inches; light brown (7.5YR 6/4) very gravelly fine sandy loam, strong brown (7.5YR 4/6) moist; moderate medium and coarse subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common very fine and few fine roots; common very fine and few fine tubular pores; many thick coats and pendants of calcium carbonate on the underside of coarse fragments; 35 percent calcium carbonate equivalent; violently effervescent; 40 percent gravel; moderately alkaline (pH 8.2); clear smooth boundary.

Bk2—7 to 13 inches; pink (7.5YR 7/3) extremely gravelly loam, brown (7.5YR 5/4) moist; massive; soft, very friable, slightly sticky and moderately plastic; few fine roots; few very fine tubular pores; many thick coats and pendants on coarse fragments; 55 percent calcium carbonate equivalent; violently effervescent; 70 percent gravel; moderately alkaline (pH 8.4); abrupt irregular boundary.

Bkm—13 to 19 inches; white (10YR 8/1) continuously indurated petrocalcic, pink (7.5YR 7/3) moist; abrupt wavy boundary.

Cr—19 to 60 inches; conglomerate.

Range in Characteristics

Depth to petrocalcic horizon: 8 to 20 inches
 Depth to conglomerate: 17 to 30 inches
 Calcium carbonate equivalent: averages 40 to 60 percent by weight in the less than 20 millimeter fraction
 Reaction: slightly alkaline to moderately alkaline
 Clay content: averages 5 to 18 percent in the particle size control section
 Rock fragments: average 35 to 75 percent

A horizon

Hue: 10YR, 7.5YR

Value: 5 or 6 dry, 4 through 6 moist

Chroma: 2 through 4, dry or moist

Bk horizon

Hue: 10YR, 7.5YR

Value: 6 through 8 dry, 4 through 8 moist

Chroma: 3 through 6, dry or moist

Bkm horizon

Hue: 7.5YR, 10YR

Value: 7 or 8 dry, 6 or 7 moist

Chroma: 1 through 4, dry or moist

Cr horizon

Consists of fanglomerate that is dominated by gravel and cobble-sized limestone, calcareous sandstone or other calcareous clasts. It is rigid through very rigid

gravelly loam, reddish yellow (7.5YR 6/6) moist; massive; hard, firm, slightly sticky and nonplastic; few fine roots; few very fine tubular and irregular pores; discontinuously, strongly cemented with calcium carbonate; violently effervescent; 65 percent gravel; moderately alkaline (pH 8.2); abrupt irregular boundary.

Bkm—17 to 21 inches; white (10YR 8/1) continuously indurated petrocalcic, pink (7.5YR 7/3) moist; abrupt wavy boundary.

Cr—21 to 60 inches; fanglomerate.

Range in Characteristics

Depth to petrocalcic horizon: 8 to 20 inches

Depth to paralithic contact: 17 to 30 inches

Calcium carbonate equivalent: averages 40 to 60 percent by weight in the less than 20 millimeter fraction

Reaction: slightly alkaline to moderately alkaline

Clay content: 5 to 18 percent in the particle size control section

Rock fragments: 35 to 75 percent in the particle size control section

A horizon

Hue: 10YR, 7.5YR

Value: 5 or 6 dry, 4 through 6 moist

Chroma: 2 through 4, dry or moist

Bk horizons

Hue: 10YR, 7.5YR

Value: 6 through 8 dry, 4 through 8 moist

Chroma: 3 through 6, dry or moist

Bkm horizon

Hue: 7.5YR, 10YR

Value: 7 or 8 dry, 6 or 7 moist

Chroma: 1 through 4, dry or moist

Cr horizon

Consists of fanglomerate that is dominated by gravel and cobble-sized limestone, calcareous sandstone or other calcareous clasts. It is rigid through very rigid when dry, friable through extremely firm when moist. It is noncemented through strongly cemented. Approximately 10 to 25 percent of an air-dried sample slakes when submerged in water.

Properties and Qualities

Meadview soils

Taxonomic classification: sandy-skeletal, mixed, thermic Durinodic Haplocalcids

Geomorphic position: side slopes of fan terraces

Parent material: alluvium

Slope: 2 to 15 percent

Surface fragments: about 45 percent coarse gravel

Drainage class: Well drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 1.1

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: High

Hydrologic group: C

Major Land Resource Area: 30

Land Resource Unit: 30-2

Ecological site name: Limy Fan 6-9" p.z.

Ecosystem site number: 030XB211AZ

Present native vegetation: creosotebush, white bursage, Nevada Mormon tea, rayless goldenhead

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 1.43 miles northeast of Gyp Wash; 36 degrees, 14 minutes, 55 seconds north latitude; 113 degrees, 55 minutes, 25 seconds west longitude.

A—0 to 2 inches; brown (7.5YR 5/4) very gravelly fine sandy loam, brown (7.5YR 4/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; few fine tubular pores; 50 percent gravel; strongly effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

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gravelly fine sand, light brown (7.5YR 6/3) moist; massive; hard, friable, slightly sticky and slightly plastic; few medium and coarse roots; few fine tubular pores; violently effervescent; weakly cemented with silica and calcium carbonate; common silica and calcium carbonate indurated lenses; 70 percent gravel; moderately alkaline (pH 8.4).

Range in Characteristics

Depth to calcic horizon: 2 to 18 inches
 Depth to gravel and sand: 20 to 30 inches
 Depth to brittle silica and calcium carbonate cemented materials: 20 to 40 inches
 Clay content: averages less than 10 percent in the control section
 Rock fragments: average 35 to 75 percent gravel, cobble, and stone in the particle size control section

A horizon

Hue: 7.5YR, 10YR
 Value: 5 or 6 dry, 4 or 5 moist
 Chroma: 3 or 4, dry or moist
 Calcium carbonate equivalent: less than 15 percent

Bk and Bkq horizon

Hue: 10YR, 7.5YR
 Value: 6 through 8 dry, 5 or 6 moist
 Chroma: 4 through 6, dry or moist
 Calcium carbonate equivalent: 15 to 25 percent

Meadview, moderately steep, soils

Taxonomic classification: sandy-skeletal, mixed, thermic Durinodic Haplocalcids
Geomorphic position: shoulders of fan terraces
Parent material: alluvium
Slope: 15 to 40 percent
Surface fragments: about 45 percent coarse gravel
Drainage class: Well drained
Permeability: about 4.00 in/hr (moderately rapid)
Available water capacity total inches: 1.1
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: very high
Hydrologic group: C
Major Land Resource Area: 30
Land Resource Unit: 30-2
Ecological site name: Limy Slopes 6-9" p.z.
Ecosystem site number: 030XB212AZ
Present native vegetation: white bursage, creosotebush, Torrey Mormon tea, white ratany
Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 1.43 miles northeast of Gyp Wash; 36 degrees, 14 minutes, 55 seconds north latitude; 113 degrees, 55 minutes, 25 seconds west longitude.

A—0 to 2 inches; brown (7.5YR 5/4) very gravelly fine sandy loam, brown (7.5YR 4/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; few fine tubular pores; 50 percent gravel; strongly effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bk1—2 to 8 inches; light brown (7.5YR 6/3) extremely gravelly fine sandy loam, brown (7.5YR 5/3) moist; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine through medium fine roots; common very fine and fine tubular pores; 70 percent gravel; strongly effervescent; common thick coats of calcium carbonate on undersides of rock fragments; moderately alkaline (pH 8.2); clear smooth boundary.

Bk2—8 to 23 inches; pink (7.5YR 8/3) extremely gravelly loamy sand, light brown (7.5YR 6/4) moist; massive; hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; few very fine tubular pores; 70 percent gravel; violently effervescent; many thick calcium carbonate coatings on rock fragments; moderately alkaline (pH 8.2); gradual smooth boundary.

2Bkq—23 to 60 inches; pink (7.5YR 8/3) extremely gravelly fine sand, light brown (7.5YR 6/3) moist; massive; hard, friable, slightly sticky and slightly plastic; few medium and coarse roots; few fine tubular pores; violently effervescent; weakly cemented with silica and calcium carbonate; common silica and calcium carbonate indurated lenses; 70 percent gravel; moderately alkaline (pH 8.4).

Range in Characteristics

Depth to calcic horizon: 2 to 18 inches
 Depth to gravel and sand: 20 to 30 inches
 Depth to brittle silica and calcium carbonate cemented materials: 20 to 40 inches
 Clay content: averages less than 10 percent in the control section
 Rock fragments: average 35 to 75 percent gravel, cobble, and stone in the particle size control section

A horizon

Hue: 7.5YR, 10YR
 Value: 5 through 7 dry, 4 or 5 moist

Chroma: 3 or 4, dry or moist
Calcium carbonate equivalent: less than 15 percent

Bk and Bkq horizon

Hue: 10YR, 7.5YR
Value: 6 or 7 dry, 5 or 6 moist
Chroma: 4 through 6, dry or moist
Calcium carbonate equivalent: 15 to 25 percent

88—Orthents-Rock outcrop complex, 2 to 6 percent slopes

Map Unit Setting

Landform: plateau
Elevation: 4,990 to 7,500 feet (1,522 to 2,286 meters)
Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)
Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)
Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)
Frost-free period: 145 to 175 days

Map Unit Composition

Orthents and similar soils: 80 percent
Rock outcrop: 20 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Orthents soils

Taxonomic classification: Orthents
Geomorphic position: washes and drainageways in ephemeral creeks of side canyons
Parent material: alluvium derived from mixed sources
Slope: 2 to 6 percent
Depth to restrictive feature: 10 to 60 inches to bedrock (lithic)
Flooding hazard: Frequent
Seasonal water table minimum depth: greater than 6 feet
Major Land Resource Area: 35
Land Resource Unit: 35-3
Ecological site name: Sandy Wash 10-14" p.z.
Ecosystem site number: 035XC357AZ
Present native vegetation: turbinella oak, Apache plume, Utah serviceberry, other deciduous trees, other evergreen trees

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 2,950 feet southwest of Indian Gardens; 36 degrees, 4 minutes, 17 seconds north latitude; 112 degrees, 7 minutes, 52 seconds west longitude.

C—0 to 60 inches; light brown (7.5YR 6/4) stratified extremely stony sand to sandy loam, brown (7.5YR 4/4) moist; single grain; loose, nonsticky and nonplastic; few very fine roots; many very fine irregular pores; 35 percent gravel, 5 percent cobble; slightly effervescent; slightly alkaline (pH 7.8).

Range in Characteristics

The soils in these landscape positions are extremely variable with respect to depth, texture, rock fragment content, and color. Because of the extreme variability, the soils here are described to the suborder only.

Rock outcrop

Canyon sidewalls

89—Oxyaquic Torriorthents-Typic Endoaquents association, 1 to 4 percent slopes

Map Unit Setting

Landform: valley floor
Elevation: 1,400 to 1,580 feet (426 to 482 meters)
Mean annual precipitation: 3 to 6 inches (76 to 152 millimeters)
Mean annual air temperature: 72 to 75 degrees F (22 to 24 degrees C)
Mean annual soil temperature: 74 to 77 degrees F (24 to 26 degrees C)
Frost-free period: 300 to 340 days

Map Unit Composition

Oxyaquic Torriorthents and similar soils: 75 percent
Typic Endoaquents and similar soils: 20 percent
Minor components: 5 percent
• Soils in channels that are devoid of vegetation and are frequently flooded

Properties and Qualities

Oxyaquic Torriorthents soils

Taxonomic classification: Oxyaquic Torriorthents
Geomorphic position: stream terraces in drainageways
Parent material: alluvium
Slope: 1 to 4 percent

Surface fragments: about 40 percent coarse gravel,
 about 10 percent cobbles, about 5 percent stones
Drainage class: Excessively drained
Permeability: about 19.98 in/hr (very rapid)
Available water capacity total inches: 1.8
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: about 48 inches
Runoff class: Negligible
Hydrologic group: A/D
Major Land Resource Area: 30
Land Resource Unit: 30-1
Ecological site name: Sandy Bottom 3-6" p.z.
Ecosystem site number: 030XA112AZ
Present native vegetation: catclaw acacia, screwbean
 mesquite, desert-willow, creosotebush, white
 burrobrush
Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 965 feet northeast of the Tassi Airport; 36 degrees, 15 minutes, 15 seconds north latitude; 113 degrees, 57 minutes, 45 seconds west longitude.

C1—0 to 1 inch; light brown (7.5YR 6/4) very gravelly loamy coarse sand, brown (7.5YR 5/4) moist; single grain; loose, nonsticky and nonplastic; few very fine roots; common very fine irregular pores; 40 percent gravel, 10 percent cobble; slightly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

C2—1 to 60 inches; light brown (7.5YR 6/4) stratified extremely stony coarse sand to extremely gravelly loamy sand, strong brown (7.5YR 5/6) moist; single grain; loose, nonsticky and nonplastic; few very fine roots; common very fine and fine irregular pores; 60 percent gravel, 5 percent cobble, 5 percent stone; slightly effervescent; moderately alkaline (pH 8.2).

Range in Characteristics

Depth to water table: 48 to greater than 60 inches
 Rock fragments: average 35 to 75 percent gravel,
 cobble or stone in the particle size control section
 Reaction: slightly alkaline to moderately alkaline
 Effervescence: slightly or strongly effervescent
 Organic matter: less than 0.5 percent

C horizons

Hue: 7.5YR, 10YR
 Value: 5 through 7 dry, 4 through 6 moist
 Chroma: 2 through 6, dry or moist

Typic Endoaquents soils

Taxonomic classification: Typic Endoaquents

Geomorphic position: flood plains in drainageways
Parent material: alluvium
Slope: 1 to 4 percent
Surface fragments: about 40 percent coarse gravel,
 about 10 percent cobbles
Drainage class: very poorly drained
Permeability: about 13.00 in/hr (rapid)
Available water capacity total inches: 1.2
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: Frequent
Seasonal water table minimum depth: At the surface
Runoff class: Negligible
Hydrologic group: A/D
Major Land Resource Area: 30
Land Resource Unit: 30-1
Ecological site name: Sandy Bottom, Wet 3-6" p.z.
Ecosystem site number: 030XA125AZ
Present native vegetation: seepwillow baccharis,
 desert broom baccharis, desert-willow, screwbean
 mesquite, catclaw acacia
Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 965 feet northeast of Tassi Airport; 36 degrees, 15 minutes, 15 seconds north latitude; 113 degrees, 57 minutes, 45 seconds west longitude.

C1—0 to 3 inches; light brown (7.5YR 6/4) very cobbly loamy sand, brown (7.5YR 5/4) moist; single grain; loose, nonsticky and nonplastic; few very fine roots; common very fine irregular pores; 15 percent gravel, 35 percent cobble, 5 percent stone; slightly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

C2—3 to 60 inches; light brown (7.5YR 6/4) stratified extremely stony coarse sand to extremely gravelly loamy sand, strong brown (7.5YR 5/6) moist (colors are apparently lithochromic); single grain; loose, nonsticky and nonplastic; few very fine roots; common very fine and fine irregular pores; 60 percent gravel, 5 percent cobble, 5 percent stone; slightly effervescent in the upper part; moderately alkaline (pH 8.2).

Range in Characteristics

Depth to water table: 0 to 20 inches
 Rock fragments: average 35 to 75 percent gravel,
 cobble or stone in the particle size control section
 Reaction: slightly alkaline to moderately alkaline
 Effervescence: slightly or strongly effervescent
 Organic matter: less than 0.5 percent

C horizons

Hue: 7.5YR, 10YR
 Value: 5 through 7 dry, 4 through 6 moist

Chroma: 2 through 6, dry or moist

90—Phizphre-Rock outcrop complex, 8 to 15 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,900 to 6,200 feet (1,798 to 1,890 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)

Mean annual soil temperature: 50 to 54 degrees F (11 to 13 degrees C)

Frost-free period: 135 to 150 days

Map Unit Composition

Phizphre and similar soils: 75 percent

Rock outcrop: 15 percent

Minor components: 10 percent

- Kellypoint soils
- Luzena soils

Properties and Qualities

Phizphre soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Argiustolls

Geomorphic position: escarpments and ridges at the edges of plateaus

Parent material: residuum weathered from cherty limestone

Slope: 8 to 15 percent

Surface fragments: about 5 percent cobbles, about 50 percent coarse gravel

Depth to restrictive feature: 14 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.40 in/hr (moderately slow)

Available water capacity total inches: 1.3

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: High

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Limestone Slopes (PIED, JUOS) 13-17" p.z.

Ecosystem site number: 035XF613AZ

Present native vegetation: muttongrass, Artemisia, Stansbury cliffrose, Colorado pinyon, Utah juniper
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Shivwits Plateau; 1.14 miles northeast of Kelly Tanks, 35 degrees, 53 minutes, 53 seconds north latitude; 113 degrees, 24 minutes, 7 seconds west longitude.

A—0 to 2 inches; brown (7.5YR 4/3) very gravelly loam; very dark brown (7.5YR 2.5/2) moist; weak fine subangular blocky structure parting to strong very fine granular; soft, very friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine and common fine irregular pores; few fossil brachiopods; 50 percent gravel, 5 percent cobble; noneffervescent; neutral (pH 6.6); abrupt smooth boundary.

Bw—2 to 7 inches; brown (7.5YR 4/3) very cobbly silt loam; very dark brown (7.5YR 2.5/2) moist; strong fine and medium subangular blocky structure; very hard, friable, moderately sticky and moderately plastic; common very fine through medium and few coarse roots; common very fine and fine tubular pores; few fossil brachiopods; 20 percent gravel, 20 percent cobble; noneffervescent; neutral (pH 6.8); clear wavy boundary.

Bt—7 to 19 inches; brown (7.5YR 4/4) extremely cobbly silty clay loam; very dark brown (7.5YR 2.5/3) moist; strong fine and medium subangular blocky structure; hard, firm, very sticky and very plastic; common fine through coarse roots; common fine and medium and few coarse tubular pores; common faint clay films on faces of peds and lining pores; few fossil brachiopods; many strong brown (7.5YR 5/6 and 7.5YR 5/8) 1- to 5-millimeter-thick laminar concretions occurring as irregular bands on cobble; few thin calcium carbonate coats on coarse fragments; 60 percent cobble; noneffervescent; neutral (pH 7.0); abrupt irregular boundary.

R—19 inches; limestone bedrock.

Range in Characteristics

Depth to bedrock: 14 to 20 inches

Rock fragments: 40 to 60 percent, dominated by cobble

Reaction: slightly acid to neutral

A horizon

Hue: 7.5YR, 10YR

Value: 4 or 5 dry, 2.5 or 3 moist

Chroma: 2 or 3, dry or moist

Bw horizons

Hue: 7.5YR, 10YR

Value: 4 or 5 dry, 2.5 or 3 moist

Chroma: 2 or 3, dry or moist

Bt horizons

Hue: 5YR, 7.5YR

Value: 3 through 5 dry, 2.5 or 3 moist

Chroma: 4 through 6 dry, 3 or 4 moist

Clay content: 30 to 35 percent

Rock outcrop

Escarments and ridges at the edges of plateaus

91—Pinntank-Retsover complex, 2 to 8 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 6,600 to 7,500 feet (2,012 to 2,290 meters)

Mean annual precipitation: 17 to 25 inches (432 to 635 millimeters)

Mean annual air temperature: 45 to 48 degrees F (7 to 9 degrees C)

Mean annual soil temperature: 47 to 50 degrees F (9 to 11 degrees C)

Frost-free period: 100 to 130 days

Map Unit Composition

Pinntank and similar soils: 45 percent

Retsover and similar soils: 40 percent

Minor components: 15 percent

- Shallow soils that have greater than 35 percent rock fragments in the profile
- Moderately deep soils that have accumulation of calcium carbonate in the profile
- Soils that have low amounts of clay in the profile

Properties and Qualities

Pinntank soils

Taxonomic classification: Fine, smectitic, mesic Vertic Paleustalfs

Geomorphic position: broad flat areas near drainageways

Parent material: residuum weathered from calcareous sandstone

Slope: 2 to 8 percent

Surface fragments: about 5 percent gravel

Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.03 in/hr (very slow)

Available water capacity total inches: 3.9

Shrink-swell potential: about 17.0 LEP (very high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: C

Major Land Resource Area: 35

Land Resource Unit: 35-8

Ecological site name: Loamy Upland (PIPO) 17-25" p.z.

Ecosystem site number: 035XH808AZ

Present native vegetation: ponderosa pine, muttongrass, Ross sedge, big wildrye, creeping barberry, other coniferous trees, other deciduous trees

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau; 3,699 feet southwest of Grandview Lookout Tower, 35 degrees, 57 minutes, 56 seconds north latitude; 111 degrees, 57 minutes, 43 seconds west longitude.

Oi—0 to 2 inches; duff layer consisting of undecomposed pine litter

A1—2 to 4 inches; brown (7.5YR 4/3) silt loam; very dark brown (7.5YR 2.5/2) moist; moderate fine subangular blocky structure parting to strong very fine granular; soft, very friable, nonsticky and nonplastic; many very fine through medium roots; many very fine and common medium tubular pores; 10 percent gravel; noneffervescent, neutral (pH 6.8); abrupt smooth boundary.

A2—4 to 6 inches; brown (7.5YR 4/3) clay loam; dark brown (7.5YR 3/3) moist; moderate fine subangular blocky structure; soft, very friable, moderately sticky and moderately plastic; many very fine through medium roots; many very fine and common medium tubular pores; 5 percent gravel; noneffervescent; neutral (pH 6.6); abrupt wavy boundary.

Bt1—6 to 10 inches; brown (7.5YR 4/3) clay; dark brown (7.5YR 3/3) moist; moderate fine and medium subangular blocky structure; slightly hard, friable, very sticky and very plastic; few very fine and fine and common medium and coarse roots; common fine and medium tubular pores; few faint clay films lining pores; 5 percent gravel; noneffervescent; neutral (pH 6.6); clear wavy boundary.

Bt2—10 to 13 inches; reddish brown (5YR 5/4) gravelly clay; reddish brown (5YR 4/4) moist; strong fine and

medium subangular blocky structure; hard, firm, very sticky and very plastic; common fine through coarse roots; common fine and medium tubular pores; common faint clay films lining pores; 30 percent gravel; noneffervescent; neutral (pH 6.6); clear wavy boundary.

Bt3—13 to 23 inches; yellowish red (5YR 5/6) clay; yellowish red (5YR 4/6) moist; moderate coarse prismatic structure parting to strong fine and medium angular blocky; very hard, very firm, very sticky and very plastic; few medium roots; few fine tubular pores; many distinct clay films on faces of peds; 5 percent gravel; noneffervescent; neutral (pH 6.6); clear wavy boundary.

Bt4—23 to 29 inches; yellowish red (5YR 5/6) gravelly clay; yellowish red (5YR 4/6) moist; strong fine subangular blocky structure parting to strong very fine angular blocky; hard, firm, very sticky and very plastic; few medium roots; few fine tubular pores; common distinct clay films on faces of peds; 25 percent gravel; noneffervescent, neutral (pH 6.6); abrupt irregular boundary.

R—29 inches; sandstone bedrock.

Range in Characteristics

Depth to bedrock: 20 to 40 inches

Calcium carbonate equivalent: Typically noneffervescent, but ranges to 5 percent calcium carbonate equivalent in some pedons immediately above the lithic contact.

Some pedons contain Cr horizons of weathered sandstone above unweathered bedrock.

Clay content: 40 to 55 percent

Rock fragments: average less than 25 percent by volume.

A horizon

Hue: 7.5YR, 10YR

Value: 3 through 5 dry, 2.5 through 4 moist

Chroma: 2 through 4, dry or moist

Bt horizons

Hue: 7.5YR, 5YR, 2.5YR

Value: 4 through 6 dry, 3 through 5 moist

Chroma: 4 through 6, dry or moist

Texture: clay (15 percent or more (absolute) clay

increase at the upper boundary within a vertical distance of 1 inch)

Retsover soils

Taxonomic classification: Fine, smectitic, mesic Vertic Haplustalfs

Geomorphic position: broad flat areas and slight depressions

Parent material: residuum weathered from calcareous sandstone

Slope: 2 to 8 percent

Surface fragments: about 10 percent gravel

Depth to restrictive feature: 40 to 60 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.03 in/hr (very slow)

Available water capacity total inches: 6.8

Shrink-swell potential: about 17.0 LEP (very high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Low

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-8

Ecological site name: Clay Loam Upland 17-25" p.z.

Ecosystem site number: 035XH801AZ

Present native vegetation: big wildrye, mountain
muhl el

structure; soft, very friable, moderately sticky and moderately plastic; common fine through coarse roots; common very fine through medium tubular pores; 30 percent gravel; few faint clay films lining pores; noneffervescent; neutral (pH 6.6); clear smooth boundary.

Bt2—16 to 29 yellowish red (5YR 5/6) clay, yellowish red (5YR 4/6) moist; strong fine and medium angular blocky structure; hard, very friable, very sticky and very plastic; few fine and medium roots; few fine and medium tubular pores; 5 percent gravel; common distinct clay films on faces of pedis; noneffervescent; neutral (pH 6.6); clear smooth boundary.

Bt3—29 to 35 inches; yellowish red (5YR 5/6) clay, yellowish red (5YR 4/6) moist; strong fine and medium angular blocky structure; hard, firm, very sticky and very plastic; few fine and medium roots; few fine and medium tubular pores; 10 percent gravel; few faint clay films on faces of pedis; noneffervescent; neutral (pH 6.8); clear smooth boundary.

Btk—35 to 44 inches; light reddish brown (5YR 6/4) clay, pink (5YR 7/4) moist; weak coarse subangular blocky structure; slightly hard, firm, very sticky and very plastic; few fine and medium roots; few fine and medium tubular pores; 10 percent gravel; few faint clay films lining pores; violently effervescent in patches; slightly alkaline (pH 7.6); abrupt smooth boundary.

R—44 inches; calcareous sandstone bedrock.

Range in Characteristics

Depth to bedrock: 40 to 60 inches

Clay content: averages from 45 to 55 percent in the particle size control section.

Rock fragments: average 5 to 15 percent in the particle size control section

Linear extensibility: 6.0 cm or more from the surface to 40 inches

A horizon

Hue: 7.5YR, 10YR

Value: 3 through 5 dry, 2 or 3 moist

Chroma: 2 through 4, dry or moist

Bt horizon(s)

Hue: 5YR, 7.5YR

Value: 3 through 6 dry, 3 through 6 moist

Chroma: 3 through 6, dry or moist

Reaction: neutral to moderately alkaline

Btk horizon

Value : 4 through 8 dry, 4 through 7 moist

Chroma: 2 through 4, dry or moist

Reaction: slightly to moderately alkaline

92—Plite-Canburn families complex, 2 to 8 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 7,980 to 9,150 feet (2,432 to 2,789 meters)

Mean annual precipitation: 25 to 33 inches (635 to 838 millimeters)

Mean annual air temperature: 36 to 45 degrees F (2 to 7 degrees C)

Mean annual soil temperature: 38 to 47 degrees F (4 to 9 degrees C)

Frost-free period: 70 to 105 days

Map Unit Composition

Plite family and similar soils: 50 percent

Canburn family and similar soils: 45 percent

Minor components: 10 percent

- Soils that have no accumulation of clay in the profile
- Soils that have more than 35 percent by volume of rock fragments
- Rock outcrop
- Soils that are shallow to bedrock
- Soils in sinkholes that are very deep and frequently ponded
- Soils in drainageways that are occasionally flooded
- Soils that have aquic moisture regimes and are classified as hydric

Properties and Qualities

Plite family soils

Taxonomic classification: Coarse-loamy, mixed, superactive, frigid Cumulic Haplustolls

Geomorphic position: fan terraces at the toe slope of hills and escarpments

Parent material: alluvium

Slope: 2 to 8 percent

Surface fragments: about 5 percent gravel

Drainage class: Well drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 6.0

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Low

Hydrologic group: B

Major Land Resource Area: 35

Land Resource Unit: 35-9

Ecological site name: Loamy Upland 25-33" p.z.

Ecosystem site number: 035XI905AZ

Present native vegetation: mountain muhly, Carex, big wildrye, sheep fescue, pine dropseed

Land capability (nonirrigated): 5c

Taxonomic Unit Description

Type Location: On the Kaibab Plateau; 1,000 feet south of Tipover Canyon; 36 degrees, 20 minutes, 29 seconds north latitude; 112 degrees, 13 minutes, 36 seconds west longitude.

A1—0 to 1 inch; dark brown (10YR 3/3) loam; very dark brown (10YR 2/2) moist; moderate very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; common very fine and few fine tubular and irregular pores; 2 percent gravel; noneffervescent; neutral (pH 6.8); abrupt smooth boundary.

A2—1 to 8 inches; dark brown (10YR 3/3) loam; very dark brown (10YR 2/2) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; common very fine and few fine tubular pores; 5 percent gravel; noneffervescent; neutral (pH 7.1); abrupt smooth boundary.

A3—8 to 10 inches; dark brown (10YR 3/3) gravelly loam; very dark brown (10YR 2/2) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and few fine tubular pores; 20 percent gravel; noneffervescent; neutral (pH 7.2); abrupt smooth boundary.

A4—10 to 29 inches; dark brown (10YR 3/3) loam; very dark brown (10YR 2/2) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and few fine roots; common very fine and few fine tubular pores; 2 percent gravel; noneffervescent; neutral (pH 7.2); abrupt smooth boundary.

C—29 to 60 inches; dark brown (10YR 3/3) loam; very dark brown (10YR 2/2) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; common few fine tubular pores; 2 percent gravel; noneffervescent; neutral (pH 7.2).

Range in Characteristics

Thickness of the mollic epipedon: 20 to 38 inches

Depth to bedrock: greater than 60 inches

Reaction: strongly acid to neutral

Rock fragments: 0 to 35 percent gravel in the particle size control section

Clay content: 8 to 15 percent in the particle size control section

A horizon(s)

Hue: 7.5YR, 10YR

Value: 3 through 5 dry, 2 through 4 moist

Chroma: 2 or 3, dry or moist

Organic matter: 1 to 4 percent

C horizon(s)

Hue: 7.5YR, 10YR

Value: 3 through 5 dry, 2 through 4 moist

Chroma: 2 or 3, dry or moist

Canburn family soils

Taxonomic classification: Fine-loamy, mixed, superactive, calcareous, frigid Cumulic Endoaquolls

Geomorphic position: flood plains and depressions in drainageways and sinkholes

Parent material: alluvium

Slope: 2 to 8 percent

Drainage class: Poorly drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 6.6

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: Frequent ponding

Seasonal water table minimum depth: about 0 inches

Runoff class: Negligible

Hydrologic group: B

Major Land Resource Area: 35

Land Resource Unit: 35-9

Ecological site name: Loamy Bottom, Subirrigated 25-33" p.z.

Ecosystem site number: 035XI904AZ

Present native vegetation: Baltic rush, Carex, spike bentgrass, tufted hairgrass, sheep fescue, timber oatgrass

Land capability (nonirrigated): 5c

Taxonomic Unit Description

Type Location: On the Kaibab Plateau; 2,681 feet south of Little Park Lake; 36 degrees, 19 minutes, 3 seconds north latitude; 112 degrees, 6 minutes, 30 seconds west longitude.

A1—0 to 12 inches; grayish brown (10YR 5/2) loam; very dark brown (10YR 3/2) moist; few fine faint strong brown (7.5YR 5/6) redox features; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; common fine tubular pores; noneffervescent; moderately acid (pH 5.6); clear smooth boundary.

A2—12 to 30 inches; grayish brown (10YR 5/2) loam; very dark brown (10YR 3/2) moist; common fine distinct strong brown (7.5YR 5/6) redox features; weak fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine and common fine roots; common very fine tubular pores; noneffervescent; moderately acid (pH 5.6); clear smooth boundary.

Bw—30 to 60 inches; grayish brown (10YR 5/2) loam; very dark brown (10YR 3/2) moist; common medium faint and few fine distinct strong brown (7.5YR 5/6) redox features; weak fine subangular blocky structure; hard, friable, slightly sticky and moderately plastic; few very fine roots; few very fine tubular pores; noneffervescent; moderately acid (pH 5.6); clear smooth boundary.

Range in Characteristics

Depth to water table: 0 to 40 inches
 Thickness of the mollic epipedon: 24 to 60 inches
 Depth to bedrock: greater than 60 inches
 Reaction: moderately acid to neutral
 Rock fragments: 0 to 35 percent gravel in the particle size control section
 Clay content: 18 to 25 percent in the particle size control section

A horizons

Hue: 7.5YR, 10YR
 Value: 3 through 5 dry, 2 or 3 moist
 Chroma: 1 or 2, dry or moist
 Redox features: faint to distinct
 Organic matter: 1 to 4 percent

Bw horizon(s)

Hue: 7.5YR, 10YR
 Value: 3 through 5 dry, 2 or 3 moist
 Chroma: 1 or 2, dry or moist
 Redox features: faint to distinct

93—Pocomate-Pinntank complex, 15 to 30 percent slopes

Map Unit Setting

Landform: plateau
Elevation: 6,600 to 7,400 feet (2,012 to 2,256 meters)
Mean annual precipitation: 17 to 25 inches (432 to 635 millimeters)
Mean annual air temperature: 45 to 48 degrees F (7 to 9 degrees C)
Mean annual soil temperature: 47 to 50 degrees F (9 to 11 degrees C)

Frost-free period: 100 to 130 days

Map Unit Composition

Pocomate and similar soils: 45 percent

Pinntank and similar soils: 40 percent

Minor components: 15 percent

- Soils that have no accumulation of clay in the profile
- Deep soils that have large amounts of rock fragments in the profile
- Shallow soils that have low amounts of clay in the profile
- Soils in drainageways that are occasionally flooded
- Deep soils that have no rock fragments, high clay content, and may contain gypsum

Properties and Qualities

Pocomate soils

Taxonomic classification: ~~Loamy skeletal~~ *Loamy skeletal*, mix *Pocriation:*

nonsticky and nonplastic; common very fine and fine roots; many very fine irregular pores; 25 percent gravel; noneffervescent; neutral (pH 6.8); abrupt smooth boundary.

Bt—8 to 14 inches; strong brown (7.5YR 5/6) very gravelly clay loam, strong brown (7.5YR 4/6) moist; moderate fine subangular blocky structure; slightly hard, very friable, moderate sticky and moderately plastic; many very fine and fine and few medium roots; common fine and medium and few coarse tubular pores; few faint clay films lining pores; 40 percent gravel; noneffervescent; neutral (pH 6.6); clear smooth boundary.

Btk—14 to 19 inches; strong brown (7.5YR 5/6) very gravelly clay loam, strong brown (7.5YR 4/6) moist; strong fine and medium subangular blocky structure; hard, firm, moderately sticky and moderately plastic; few fine and medium roots; few medium and coarse tubular pores; common faint clay films lining pores and on faces of peds; 50 percent gravel; slightly effervescent; neutral (pH 6.6); abrupt irregular boundary.

R—19 inches; hard cherty limestone bedrock.

Range in Characteristics

Depth to bedrock: 8 to 20 inches

Rock fragments: average 40 to 45 percent in the particle size control section

Clay content: averages 30 to 35 percent in the particle size control section

A horizon

Hue: 10YR, 7.5YR

Value: 3 or 4 dry, 2 or 3 moist

Chroma: 2 or 3, dry or moist

Mollic epipedon may include part of or the entire argillic horizon.

Bt horizon

Hue: 5YR, 7.5YR

Value: 3 through 5 dry, 3 or 4 moist

Chroma: 4 through 6

Btk horizon

Hue: 7.5YR, 10YR

Value: 3 through 5 dry, 2 or 3 moist

Chroma: 3 or 4, dry or moist

Calcium carbonate equivalent: 1 to 15 percent

Pinntank soils

Taxonomic classification: Fine, smectitic, mesic Vertic Paleustalfs

Geomorphic position: summits and footslopes of hills and ridges

Parent material: residuum weathered from calcareous sandstone

Slope: 15 to 30 percent

Surface fragments: about 5 percent cobbles, about 20 percent gravel

Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.03 in/hr (very slow)

Available water capacity total inches: 4.8

Shrink-swell potential: about 17.0 LEP (very high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-8

Ecological site name: Loamy Hills (PIPO) 17-25" p.z.

Ecosystem site number: 035XH805AZ

Present native vegetation: muttongrass, ponderosa pine, Gambel oak, Ross sedge, big wildrye

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau; 2,220 feet east of Buggeln Tank, 35 degrees, 58 minutes, 35 seconds north latitude; 111 degrees, 56 minutes, 41 seconds west longitude.

A—0 to 2 inches; brown (10YR 4/3) gravelly loam, very dark grayish brown 10YR 3/2) moist; moderate fine and medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine tubular pores; 30 percent gravel, 5 percent cobble; noneffervescent; neutral (pH 6.8); abrupt smooth boundary.

Bt1—2 to 9 inches; brown (7.5YR 4/3) gravelly clay, dark brown (7.5YR 3/2) moist; moderate fine and medium subangular blocky structure; soft, very friable, moderately sticky and moderately plastic; many very fine through medium and few coarse roots; common fine and medium and few coarse tubular pores; many faint clay films on faces of peds; 30 percent gravel; noneffervescent; neutral (pH 6.8); clear wavy boundary.

Bt2—9 to 17 inches; yellowish red (5YR 5/6) gravelly clay, yellowish red (5YR 4/6) moist; strong fine and medium angular blocky structure; very hard, firm, very sticky and very plastic; common fine through coarse roots; common very fine through medium and few

coarse tubular pores; many faint clay films on faces of peds; 30 percent gravel; noneffervescent; neutral (pH 6.8); clear wavy boundary.

Btss1—17 to 26 inches; yellowish red (5YR 5/6) gravelly clay, yellowish red (5YR 4/6) moist; strong medium angular blocky structure; very hard, firm, very sticky and very plastic; common fine through coarse roots; few medium and coarse tubular pores; few faint clay films on faces of peds; common intersecting slickensides; 25 percent gravel; noneffervescent; neutral (pH 6.8); clear wavy boundary.

Btss2—26 to 36 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; massive; very hard, very firm, very sticky and very plastic; few medium roots; few medium tubular pores; 10 percent gravel; few faint clay films lining pores; common intersecting slickensides; noneffervescent; neutral (pH 6.8); abrupt smooth boundary.

R—36 inches; hard sandstone bedrock.

Range in Characteristics

Depth to bedrock: 20 to 40 inches

Calcium carbonate equivalent: Typically noneffervescent, but ranges to 5 percent calcium carbonate equivalent in some pedons immediately above the lithic contact.

Clay content: 40 to 55 percent in the particle size control section

Rock fragments: average less than 25 percent by volume in the particle size control section.

A horizon

Hue: 7.5YR, 10YR

Value: 3 through 5 dry, 2 through 4 moist

Chroma: 2 through 4, dry or moist

Bt horizons

Hue: 7.5YR, 5YR, 2.5YR

Value: 4 through 6 dry, 3 through 5 moist

Chroma: 4 through 6, dry or moist

Texture: clay (15 percent or more (absolute) clay increase at the upper boundary within a vertical distance of 1 inch)

Some pedons contain Cr horizons of weathered sandstone above unweathered bedrock.

94—Pocomate-Pinntank-Toqui complex, 15 to 25 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 6,420 to 7,430 feet (1,958 to 2,265 meters)
Mean annual precipitation: 14 to 25 inches (330 to 635 millimeters)

Mean annual air temperature: 45 to 52 degrees F (7 to 11 degrees C)

Mean annual soil temperature: 47 to 54 degrees F (9 to 13 degrees C)

Frost-free period: 100 to 160 days

Map Unit Composition

Pocomate and similar soils: 40 percent

Pinntank and similar soils: 35 percent

Toqui and similar soils: 15 percent

Minor components: 10 percent

- Shallow, loamy soils that have high amounts of organic matter in the surface

- Shallow soils that have large amounts of rock fragments and accumulation of calcium carbonate in the profile

- Soils in drainageways that are subject to occasional flooding

Properties and Qualities

Pocomate soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Argiustolls

Geomorphic position: summits

Parent material: residuum weathered from cherty limestone

Slope: 15 to 25 percent

Surface fragments: about 5 percent gravel, about 45 percent cobbles

Depth to restrictive feature: 8 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.13 in/hr (slow)

Available water capacity total inches: 0.9

Shrink-swell potential: about 1.5 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-8

Ecological site name: Loamy Hills (PIPO) 17-25" p.z.

Ecosystem site number: 035XH805AZ

Present native vegetation: muttongrass, ponderosa pine, Gambel oak, Ross sedge, big wildrye

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau; 1.39 miles

northeast of Halfway Tank, 35 degrees, 58 minutes, 40 seconds north latitude; 112 degrees, 0 minutes, 30 seconds west longitude.

A—0 to 1 inch; dark brown (7.5YR 3/3) very cobbly silt loam; dark brown (7.5YR 3/2) moist; strong thin platy structure; soft, very friable, slightly sticky and slightly plastic; many very fine and common fine roots; many very fine irregular pores; 5 percent gravel, 40 percent cobble; noneffervescent; neutral (pH 6.8); abrupt smooth boundary.

Bt—1 to 5 inches; dark brown (7.5YR 3/2) very cobbly silty clay loam; dark brown (7.5YR 3/2) moist; strong medium subangular blocky structure parting to strong fine angular blocky; hard, friable, moderately sticky and moderately plastic; many very fine and fine and few medium and coarse roots; common fine tubular pores; common distinct clay films lining pores and on faces of peds; 15 percent gravel, 25 percent cobble; noneffervescent, neutral (pH 6.8); abrupt irregular boundary.

Btk—5 to 10 inches; dark brown (7.5YR 3/4) very cobbly silty clay; dark brown (7.5YR 3/3) moist; strong medium subangular blocky structure parting to strong fine angular blocky; hard, firm, very sticky and very plastic; common very fine and few fine roots; few fine tubular pores; many distinct clay films lining pores and on faces of peds; 20 percent gravel, 20 percent cobble, and 5 percent stone; slightly effervescent; neutral (pH 6.8); abrupt broken boundary.

R—10 inches; fractured cherty limestone bedrock.

Range in Characteristics

Depth to bedrock: 8 to 20 inches

Rock fragments: average 35 to 55 percent in the particle size control section

Clay content: averages 30 to 35 percent in the particle size control section

A horizon

Hue: 10YR, 7.5YR

Value: 3 or 4 dry, 2 or 3 moist

Chroma: 2 to 3 dry or moist

Mollic epipedon may include part of or the entire argillic horizon.

Bt horizon

Hue: 5YR, 7.5YR

Value: 3 through 5 dry, 3 or 4 moist

Chroma: 3 or 4

Texture of fine earth: silty clay loam, clay loam, silty clay

Btk horizon

Hue: 7.5YR, 10YR

Value: 3 through 6 dry, 2 or 3 moist

Chroma: 3 or 4, dry or moist

Calcium carbonate equivalent: 1 to 15 percent

McGuire-Nicholas

Pinntank soils

Taxonomic classification: Fine, smectitic, mesic Vertic Paleustalfs

Geomorphic position: summits and footslopes of hills and ridges

Parent material: residuum weathered from calcareous sandstone

Slope: 15 to 30 percent

Surface fragments: about 5 percent cobbles, about 20 percent gravel

Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.03 in/hr (very slow)

Available water capacity total inches: 4.8

Shrink-swell potential: about 17.0 LEP (very high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-8

Ecological site name: Loamy Hills (PIPO) 17-25" p.z.

Ecosystem site number: 035XH805AZ

Present native vegetation: muttongrass, ponderosa pine, Gambel oak, Ross sedge, big wildrye

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau; 1.79 miles north of Halfway Tank, 35 degrees, 59 minutes, 42 seconds north latitude; 112 degrees, 2 minutes, 11 seconds west longitude.

A1—0 to 2 inches; light brown (7.5YR 6/3) loam; brown (7.5YR 4/3) moist; weak thin platy structure parting to weak fine subangular blocky; soft, very friable, nonsticky and nonplastic; common very fine roots; common very fine tubular pores; 10 percent gravel; noneffervescent, neutral (pH 6.9); clear smooth boundary.

A2—2 to 5 inches; light brown (7.5YR 6/3) loam; brown (7.5YR 4/3) moist; weak thin platy structure parting to weak very fine and fine subangular blocky; slightly hard, very friable, nonsticky and nonplastic; common

very fine roots; common very fine tubular pores; 10 percent gravel; noneffervescent, neutral (pH 6.9); clear smooth boundary.

Bw1—5 to 10 inches; light brown (7.5YR 6/4) loam; brown (7.5YR 4/4) moist; moderate fine subangular blocky; slightly hard, very friable, nonsticky and slightly plastic; common very fine and few fine roots; few very fine and fine tubular pores; 5 percent gravel; noneffervescent, neutral (pH 6.9); clear smooth boundary.

Bw2—10 to 16 inches; light brown (7.5YR 6/4) loam; brown (7.5YR 4/4) moist; moderate fine subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few very fine and fine roots; few very fine and fine tubular pores; noneffervescent, neutral (pH 6.9); abrupt smooth boundary.

Bt1—16 to 20 inches; reddish brown (5YR 5/4) clay loam; reddish brown (5YR 4/4) moist; moderate fine and medium subangular blocky structure; hard, friable, moderately sticky and moderately plastic; few very fine and fine roots; common very fine and few fine tubular pores; common faint clay films bridging sand grains and lining pores; noneffervescent, neutral (pH 6.9); clear smooth boundary.

Bt2—20 to 26 inches; reddish brown (5YR 5/4) clay; reddish brown (5YR 4/4) moist; moderate fine and medium subangular blocky structure; hard, firm, very sticky and very plastic; few very fine and fine roots; common very fine and few fine tubular pores; many faint clay films lining pores and common distinct clay films on faces of peds; 5 percent weathered chert and limestone gravel; noneffervescent, neutral (pH 6.9); clear smooth boundary.

Bt3—26 to 29 inches; reddish brown (5YR 4/4) clay; dark reddish brown (5YR 3/4) moist; moderate fine and medium subangular blocky structure; very hard, very firm, very sticky and very plastic; few very fine and fine roots; common very fine and few fine tubular pores; many faint clay films lining pores and on faces of peds and common distinct clay films on faces of peds; 5 percent weathered chert and limestone gravel; noneffervescent, neutral (pH 6.9); abrupt irregular boundary.

R—29 inches; hard, fractured sandstone bedrock.

Range in Characteristics

Depth to bedrock: 25 to 40 inches

Calcium carbonate equivalent: Typically noneffervescent, but ranges to 5 percent calcium carbonate equivalent in some pedons immediately above the lithic contact.

Some pedons contain Cr horizons of weathered sandstone above unweathered bedrock.

Clay content: 40 to 55 percent

Rock fragments: average less than 25 percent by volume.

A horizon

Hue: 7.5YR, 10YR

Value: 3 through 5 dry, 2 through 4 moist

Chroma: 2 through 4, dry or moist

Bt horizons

Hue: 7.5YR, 5YR, 2.5YR

Value: 4 through 6 dry, 3 through 5 moist

Chroma: 4 through 6, dry or moist

Texture: clay (15 percent or more (absolute) clay increase at the upper boundary within a vertical distance of 1 inch)

Toqui soils

Taxonomic classification: Clayey, smectitic, mesic Lithic Haplustalfs

Geomorphic position: summits

Parent material: residuum weathered from cherty limestone

Slope: 15 to 25 percent

Surface fragments: about 5 percent stones, about 5 percent cobbles, about 5 percent gravel

Depth to restrictive feature: 8 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.03 in/hr (very slow)

Available water capacity total inches: 1.6

Shrink-swell potential: about 7.5 LEP (high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Clay Loam Upland, Gravelly (PIED, JUOS) 13-17" p.z.

Ecosystem site number: 035XF611AZ

Present native vegetation: muttongrass, Utah juniper, Wyoming big sagebrush, blue grama, Colorado pinyon

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau; 1,933 feet south of Shoshone Point; 36 degrees, 2 minutes, 23 seconds north latitude; 112 degrees, 3 minutes, 40 seconds west longitude.

A—0 to 3 inches; light brown (7.5YR 4/6) silt loam; dark brown (7.5YR 3/3) moist; strong thick platy structure; hard, very friable, moderately sticky and moderately plastic; common very fine roots; common very fine and fine vesicular pores; 2 percent gravel, 2 percent cobble, and 5 percent stone; noneffervescent; neutral (pH 6.6); abrupt smooth boundary.

Bt1—3 to 6 inches; reddish brown (5YR 4/4) silty clay loam; dark reddish brown (5YR 3/3) moist; strong medium subangular blocky structure; hard, friable, very sticky and very plastic; common very fine and fine roots; common fine tubular pores; many faint clay films bridging sand grains; noneffervescent, neutral (pH 6.6); abrupt smooth boundary.

Bt2—6 to 9 inches; reddish brown (5YR 4/4) silty clay; dark reddish brown (5YR 3/4) moist; strong medium subangular blocky structure parting to strong fine angular blocky; very hard, firm, very sticky and very plastic; many very fine and fine roots; common fine tubular pores; common moderately thick clay films bridging sand grains and few distinct clay films on faces of peds; noneffervescent, neutral (pH 6.6); abrupt irregular boundary.

R—9 inches; fractured cherty limestone bedrock.

Range in Characteristics

Depth to bedrock: 8 to 20 inches

A horizon

Hue: 7.5YR

Value: 3 through 5 dry, 3 or 4 moist

Chroma: 3 through 6 dry, 2 through 4 moist

Reaction: slightly acid to slightly alkaline

Bt horizon

Hue: 5YR, 7.5YR

Value: 3 through 5 dry, 3 or 4 moist

Chroma: 3 through 6, dry or moist

Rock fragments: averages 0 to 35 percent, mostly gravel

Clay content: averages 35 to 50 percent, may be less in some horizons

Some pedons may have Bk or Btk horizons.

95—Pocomate-Pinntank-Ustifluvents complex, 2 to 30 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 6,600 to 7,400 feet (2,012 to 2,256 meters)

Mean annual precipitation: 17 to 25 inches (432 to 635 millimeters)

Mean annual air temperature: 45 to 48 degrees F (7 to 9 degrees C)

Mean annual soil temperature: 47 to 50 degrees F (9 to 11 degrees C)

Frost-free period: 100 to 130 days

Map Unit Composition

Pocomate and similar soils: 45 percent

Pinntank and similar soils: 35 percent

Ustifluvents and similar soils: 15 percent

Minor components: 5 percent

- Shallow soils that have small amounts of rock fragments in the profile

- Deep soils that have large amounts of rock fragments in the profile

- Shallow soils that have accumulation of calcium carbonate in the profile

Properties and Qualities

Pocomate soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Argiustolls

Geomorphic position: side slopes and shoulders of drainageways

Parent material: residuum weathered from cherty limestone

Slope: 15 to 30 percent

Surface fragments: about 55 percent gravel

Depth to restrictive feature: 8 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.40 in/hr (moderately slow)

Available water capacity total inches: 0.7

Shrink-swell potential: about 1.5 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-8

Ecological site name: Loamy Hills (PIPO) 17-25" p.z.

Ecosystem site number: 035XH805AZ

Present native vegetation: muttongrass, ponderosa pine, Gambel oak, Ross sedge, big wildrye

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau; 1.14 miles northeast of The Abyss; 36 degrees, 2 minutes, 48

seconds north latitude; 112 degrees, 9 minutes, 49 seconds west longitude.

A—0 to 2 inches; brown (10YR 4/3) very gravelly loam; dark brown (10YR 3/2) moist; strong thick platy structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and common fine roots; many very fine and fine vesicular pores; 45 percent gravel; noneffervescent; slightly acid (pH 6.2); abrupt smooth boundary.

Bt—2 to 8 inches; brown (10YR 4/3) very gravelly loam; dark brown (10YR 3/2) moist; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and common fine roots; few fine tubular pores; common faint clay films on faces of peds; 55 percent gravel; noneffervescent; neutral (pH 6.6); abrupt smooth boundary.

Btk—8 to 13 inches; yellowish brown (10YR 5/4) very gravelly clay loam; brown (10YR 4/3) moist; moderate medium subangular blocky structure; slightly hard, friable, moderately sticky and moderately plastic; many very fine and common fine roots; few fine tubular pores; common faint clay films on faces of peds; 55 percent gravel; slightly effervescent in patches; neutral (pH 6.8); abrupt irregular boundary.

R—13 inches; cherty limestone bedrock with a 1-inch-thick weathering rind.

Range in Characteristics

Depth to bedrock: 8 to 20 inches

Rock fragments: average 55 to 65 percent in the particle size control section

Clay content: averages 20 to 30 percent in the particle size control section

A horizon

Hue: 10YR, 7.5YR

Value: 3 or 4 dry, 2 or 3 moist

Chroma: 2 or 3, dry or moist

Mollic epipedon may include part of, or the entire, argillic horizon

Bt horizon

Hue: 5YR, 7.5YR

Value: 3 through 5 dry, 3 or 4 moist

Chroma: 3 or 4 dry, 2 or 3 moist

Btk horizon

Hue: 7.5YR, 10YR

Value: 3 through 5 dry, 2 or 3 moist

Chroma: 3 or 4, dry or moist

Calcium carbonate equivalent: 1 to 15 percent

Pinntank soils

Taxonomic classification: Fine, smectitic, mesic Vertic Paleustalfs

Geomorphic position: summits and footslopes of hills and ridges

Parent material: residuum weathered from calcareous sandstone

Slope: 15 to 30 percent

Surface fragments: about 5 percent cobbles, about 20 percent gravel

Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.03 in/hr (very slow)

Available water capacity total inches: 4.8

Shrink-swell potential: about 17.0 LEP (very high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-8

Ecological site name: Loamy Hills (PIPO) 17-25" p.z.

Ecosystem site number: 035XH805AZ

Present native vegetation: muttongrass, ponderosa pine, Gambel oak, Ross sedge, big wildrye

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau; 3,857 feet west of Grand Canyon; 36 degrees, 3 minutes, 5 seconds north latitude; 112 degrees, 9 minutes, 4 seconds west longitude.

A—0 to 3 inches; dark yellowish brown (10YR 4/4) very gravelly loam; dark brown (7.5YR 3/3) moist; weak coarse prismatic structure; soft, very friable, moderately sticky and moderately plastic; many very fine and fine roots; many very fine irregular and common fine tubular pores; 50 percent gravel, 5 percent cobble; noneffervescent; neutral (pH 7.0); abrupt smooth boundary.

Bw—3 to 8 inches; dark brown (10YR 3/3) clay loam; very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; slightly hard, friable, moderately sticky and moderately plastic; many very fine through medium roots; common very fine irregular and few fine tubular pores; 5 percent gravel; noneffervescent; slightly alkaline (pH 7.6); abrupt smooth boundary.

Bt1—8 to 13 inches; dark brown (7.5YR 3/4) clay; dark brown (7.5YR 3/4) moist; strong medium subangular blocky structure parting to strong fine angular blocky; hard, firm, very sticky and very plastic; many fine through coarse roots; few fine tubular pores; many distinct clay films lining pores and on faces of peds; many distinct pressure faces on peds; common dark organic stains; 5 percent gravel; slightly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

Bt2—13 to 26 inches; brown (7.5YR 4/4) clay; dark brown (7.5YR 3/4) moist; strong medium subangular blocky structure parting to strong fine angular blocky; hard, firm, very sticky and very plastic; many fine through coarse roots; few fine tubular pores; many distinct pressure faces on peds; 5 percent gravel; strongly effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

R—26 inches; calcareous sandstone bedrock.

Range in Characteristics

Depth to bedrock: 20 to 40 inches

Calcium carbonate equivalent: Typically noneffervescent, but ranges to 5 percent calcium carbonate equivalent in some pedons immediately above the lithic contact.

Some pedons contain Cr horizons of weathered sandstone above unweathered bedrock.

Clay content: 40 to 55 percent

Rock fragments: average less than 25 percent by volume.

A horizon

Hue: 7.5YR, 10YR

Value: 3 through 5 dry, 2 through 4 moist

Chroma: 2 through 4, dry or moist

Bt horizons

Hue: 7.5YR, 5YR, 2.5YR

Value: 3 through 6 dry, 3 through 5 moist

Chroma: 4 through 6, dry or moist

Texture: clay (15 percent or more (absolute) clay increase at the upper boundary within a vertical distance of 1 inch)

Ustifluvents soils

Taxonomic classification: Ustifluvents

Geomorphic position: flood plains of drainageways

Parent material: alluvium derived from mixed sources

Slope: 2 to 15 percent

Surface fragments: about 5 percent gravel

Depth to restrictive feature: 40 to 60 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.13 in/hr (slow)

Available water capacity total inches: 7.3

Shrink-swell potential: about 4.5 LEP (moderate)

Flooding hazard: Occasional

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Low

Hydrologic group: B

Major Land Resource Area: 35

Land Resource Unit: 35-8

Ecological site name: Loamy Terrace (PIPO) 17-25" p.z.

Ecosystem site number: 035XH806AZ

Present native vegetation: Wyoming big sagebrush, muttongrass, ponderosa pine, prairie Junegrass, western wheatgrass, Gambel oak

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau; 36 degrees, 2 minutes, 11 seconds north latitude; 112 degrees, 9 minutes, 54 seconds west longitude.

A1—0 to 2 inches; brown (10YR 4/3) silt loam, dark brown (10YR 3/3) moist; moderate fine subangular blocky structure; slightly hard, very friable; slightly sticky and nonplastic; many very fine and fine roots; common very fine irregular and few fine tubular pores; 5 percent gravel; slightly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

A2—2 to 10 inches; dark yellowish brown (10YR 4/4) silt loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; many very fine and fine roots; common very fine and fine tubular pores; slightly effervescent; slightly alkaline (pH 7.8); clear smooth boundary.

Bw1—10 to 23 inches; dark brown (7.5YR 3/3) silty clay loam, dark brown (7.5YR 3/2) moist; moderate medium subangular blocky structure; hard, friable, moderately sticky and moderately plastic; common fine and few very fine medium and coarse roots; many very fine and fine and few medium tubular pores; noneffervescent; slightly alkaline (pH 7.8); clear smooth boundary.

Bw2—23 to 32 inches; brown (7.5YR 4/4) loam, dark brown (7.5YR 3/3) moist; strong fine subangular blocky structure; slightly hard, friable, moderately sticky and moderately plastic; few very fine through coarse roots; few fine and medium tubular pores; noneffervescent; slightly alkaline (pH 7.8); clear smooth boundary.

2Bwb1—32 to 45 inches; brown (7.5YR 4/4) silty clay

loam, dark brown (7.5YR 3/3) moist; strong fine subangular blocky structure; slightly hard, friable, moderately sticky and moderately plastic; few very fine through coarse roots; few fine and medium tubular pores; strongly effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

2Bwb2—45 to 60 inches; strong brown (7.5YR 4/6) loam, reddish brown (7.5YR 4/4) moist; strong fine subangular blocky structure; slightly hard, friable, moderately sticky and moderately plastic; few very fine through coarse roots; few fine and medium tubular pores; strongly effervescent; moderately alkaline (pH 8.2).

Range in Characteristics

Ustifluvents are highly variable with respect to depth, rock fragment content, clay content and color. The soil profile described is one example of what may exist on this landform position.

96—Pompeii family-Huevi-Huevi, moderately steep complex, 2 to 25 percent slopes

Map Unit Setting

Landform: fan terrace

Elevation: 1,200 to 1,600 feet (366 to 488 meters)

Mean annual precipitation: 3 to 6 inches (76 to 152 millimeters)

Mean annual air temperature: 70 to 75 degrees F (21 to 24 degrees C)

Mean annual soil temperature: 72 to 77 degrees F (23 to 26 degrees C)

Frost-free period: 300 to 365 days

Map Unit Composition

Pompeii family and similar soils: 60 percent

Huevi and similar soils: 15 percent

Huevi, moderately steep, and similar soils: 15 percent

Minor components: 10 percent

- Carrizo, occasionally flooded
- Outcrops of gypsum bearing lacustrine sediments
- Pompeii family soils on steeper slopes
- Soils that have a stony and cobbly surface phase

Properties and Qualities

Pompeii family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, hyperthermic, shallow Typic Petrocalcids

Geomorphic position: summits and shoulders

Parent material: alluvium

Slope: 2 to 7 percent

Surface fragments: about 50 percent coarse gravel, about 5 percent cobbles

Depth to restrictive feature: 4 to 20 inches to petrocalcic

Drainage class: Somewhat excessively drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 0.7

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Medium

Hydrologic group: D

Major Land Resource Area: 30

Land Resource Unit: 30-1

Ecological site name: Limy Upland 3-6" p.z.

Ecosystem site number: 030XA108AZ

Present native vegetation: creosotebush, rayless brittlebush, white bursage, white ratany

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 3,215 feet north of Burro Spring; 36 degrees, 17 minutes, 28 seconds north latitude; 114 degrees, 0 minutes, 0 seconds west longitude.

A—0 to 1 inch; light yellowish brown (10YR 6/4) very gravelly loam, dark yellowish brown (10YR 3/6) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine roots; common very fine and fine tubular pores; 50 percent gravel; slightly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

Bk—1 to 8 inches; light brown (7.5YR 6/4) very gravelly loam, strong brown (7.5YR 4/6) moist; moderate fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and fine roots; few fine tubular pores; 45 percent gravel; thick coats and pendants of calcium carbonate on undersides and sides of rock fragments; strongly effervescent; moderately alkaline (pH 8.0); clear smooth boundary.

Bkm—8 to 15 inches; indurated petrocalcic horizon.

R—15 inches; hard fanglomerate.

Range in Characteristics

Depth to petrocalcic horizon: 4 to 20 inches

Depth to fanglomerate: 12 to 25 inches

Rock fragments: average 35 to 60 percent in the particle size control section

Organic matter content: less than 1 percent

A horizon

Hue: 7.5YR, 10YR

Value: 5 through 7 dry, 3 through 5 moist

Chroma: 3 through 6, dry or moist

Bk horizons

Hue: 7.5YR, 10YR

Value: 6 through 8 dry, 4 through 6 moist

Chroma: 3 through 6, dry or moist

Petrocalcic horizon

May occur as 5- to 10-inch thick calcium carbonate cemented layers alternating with layers of noncemented soil material over fanglomerate.

Huevi soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, hyperthermic Durinodic Haplocalcids

Geomorphic position: back slopes

Parent material: alluvium

Slope: 2 to 15 percent

Surface fragments: about 40 percent coarse gravel, about 5 percent stones, about 15 percent cobbles

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 2.2

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Medium

Hydrologic group: C

Major Land Resource Area: 30

Land Resource Unit: 30-1

Ecological site name: Limy Upland, Deep 3-6" p.z.

Ecosystem site number: 030XA109AZ

Present native vegetation: creosotebush, white bursage, Nevada Mormon tea, white ratany

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 4,298 feet north of Burro Spring; 36 degrees, 17 minutes, 40 seconds north latitude; 114 degrees, 0 minutes, 5 seconds west longitude.

A—0 to 2 inches; strong brown (7.5YR 5/6) extremely gravelly fine sandy loam, brown (7.5YR 4/4) moist; weak moderate platy structure; slightly hard, very friable, nonsticky and nonplastic; few very fine and fine roots; common very fine and fine tubular pores; 45

percent gravel, 15 percent cobble, 5 percent stone; slightly effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bk—2 to 10 inches; reddish yellow (7.5YR 6/6) very gravelly fine sandy loam, brown (7.5YR 4/6) moist; weak fine subangular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and common medium roots; many very fine through medium tubular pores; 40 percent gravel; common thin coats of calcium carbonate on undersides and sides of rock fragments; strongly effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

2Bkq1—10 to 15 inches; light brown (7.5YR 6/4) extremely gravelly loam, strong brown (7.5YR 5/6) moist; massive; soft, very friable, slightly sticky and moderately plastic; common very fine parting to medium roots; few fine tubular pores; 75 percent gravel; many thick coats and pendants of calcium carbonate and silica on the undersides and sides of rock fragments; common lenses strongly cemented with silica and calcium carbonate; strongly effervescent; moderately alkaline (pH 8.2); gradual wavy boundary.

2Bkq2—15 to 47 inches; light brown (7.5YR 6/4) extremely cobbly fine sandy loam, strong brown (7.5YR 5/6) moist; massive; brittle, very friable, slightly sticky and moderately plastic; few very fine and fine roots; common very fine and fine tubular pores; 35 percent gravel, 25 percent cobble, 10 percent stone; common lenses strongly cemented with silica and calcium carbonate; violently effervescent; moderately alkaline (pH 8.2); gradual wavy boundary.

2Bkq3—47 to 60 inches; reddish yellow (7.5YR 6/6) extremely gravelly sandy loam, reddish yellow (7.5YR 6/6) moist; massive; hard, firm, nonsticky and nonplastic; few very fine roots; common very fine and fine tubular pores; 65 percent gravel, 5 percent cobble; common very coarse masses of material strongly cemented with silica and calcium carbonate; common lenses of single grain material; strongly effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Depth to calcic horizon: 2 to 6 inches

Depth to silica cementation: 7 to 21 inches

Rock fragments: average 35 to 80 percent in the particle size control section

Clay content: averages 8 to 18 percent in the particle size control section

Calcium carbonate equivalent: 15 to 35 percent in the less than 20 millimeter fraction

A horizon

Hue: 10YR, 7.5YR
 Value: 5 through 7 dry, 4 or 5 moist
 Chroma: 3 through 6, dry or moist

Bk horizon

Hue: 10YR, 7.5YR
 Value: 6 or 7 dry, 4 through 6 moist
 Chroma: 3 through 6, dry or moist

2Bqk horizons

Hue: 10YR, 7.5YR
 Value: 6 through 8 dry, 4 through 6 moist
 Chroma: 2 through 6, dry or moist
 Texture: fine sandy loam, sandy loam, loam
 Cementation: continuously or discontinuously weakly silica and calcium carbonate cemented with 20 to 50 percent strong silica and calcium carbonate cementation occurring as concretions, durinodes, or lenses within the matrix. These are hard or very hard when dry, and brittle when moist, and do not slake in dilute hydrochloric acid.

Additional features: Some pedons have weakly silica cemented stratified C horizons below the Bqk horizon that average coarse sandy loams through loams in the fine earth fraction, modified by 35 to 80 percent coarse fragments, predominantly gravel and cobble.

Huevi, moderately steep, soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, hyperthermic Durinodic Haplocalcids
Geomorphic position: summits
Parent material: alluvium
Slope: 15 to 25 percent
Surface fragments: about 5 percent stones, about 40 percent coarse gravel, about 15 percent cobbles
Drainage class: Well drained
Permeability: about 1.30 in/hr (moderate)
Available water capacity total inches: 2.7
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: High
Hydrologic group: C
Major Land Resource Area: 30
Land Resource Unit: 30-1
Ecological site name: Limy Hills 3-6" p.z.
Ecosystem site number: 030XA106AZ
Present native vegetation: creosotebush, white bursage, white brittlebush

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 4,298 feet north of Burro Spring; 36 degrees, 17 minutes, 40 seconds north latitude; 114 degrees, 0 minutes, 5 seconds west longitude.

A—0 to 2 inches; strong brown (7.5YR 5/6) extremely gravelly fine sandy loam, brown (7.5YR 4/4) moist; weak moderate platy structure; slightly hard, very friable, nonsticky and nonplastic; few very fine and fine roots; common very fine and fine tubular pores; 45 percent gravel, 15 percent cobble, 5 percent stone; slightly effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bk—2 to 10 inches; reddish yellow (7.5YR 6/6) very gravelly fine sandy loam, brown (7.5YR 4/6) moist; weak fine subangular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and common medium roots; many very fine through medium tubular pores; 40 percent gravel; common thin coats of calcium carbonate on undersides and sides of rock fragments; strongly effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

2Bkq1—10 to 15 inches; light brown (7.5YR 6/4) extremely gravelly loam, strong brown (7.5YR 5/6) moist; massive; soft, very friable, slightly sticky and moderately plastic; common very fine parting to medium roots; few fine tubular pores; 75 percent gravel; many thick coats and pendants of calcium carbonate and silica on the undersides and sides of rock fragments; common lenses strongly cemented with silica and calcium carbonate; strongly effervescent; moderately alkaline (pH 8.2); gradual wavy boundary.

2Bkq2—15 to 47 inches; light brown (7.5YR 6/4) extremely cobbly fine sandy loam, strong brown (7.5YR 5/6) moist; massive; brittle, very friable, slightly sticky and moderately plastic; few very fine and fine roots; common very fine and fine tubular pores; 35 percent gravel, 25 percent cobble, 10 percent stone; common lenses strongly cemented with silica and calcium carbonate; violently effervescent; moderately alkaline (pH 8.2); gradual wavy boundary.

2Bkq3—47 to 60 inches; reddish yellow (7.5YR 6/6) extremely gravelly sandy loam, reddish yellow (7.5YR 6/6) moist; massive; hard, firm, nonsticky and nonplastic; few very fine roots; common very fine and fine tubular pores; 65 percent gravel, 5 percent cobble;

common very coarse masses of material strongly cemented with silica and calcium carbonate; common lenses of single grain material; strongly effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Depth to calcic horizon: 2 to 6 inches

Depth to silica cementation: 7 to 21 inches

Rock fragments: average 35 to 80 percent in the particle size control section

Clay content: averages 8 to 18 percent in the particle size control section

Calcium carbonate equivalent: 15 to 35 percent in the less than 20 millimeter fraction

A horizon

Hue: 10YR, 7.5YR

Value: 6 or 7 dry, 4 or 5 moist

Chroma: 3 through 6, dry or moist

Bk horizon

Hue: 10YR, 7.5YR

Value: 6 or 7 dry, 4 through 6 moist

Chroma: 3 through 6, dry or moist

2Bqk horizons

Hue: 10YR, 7.5YR

Value: 6 through 8 dry, 4 through 6 moist

Chroma: 2 through 6, dry or moist

Texture: fine sandy loam, sandy loam, loam

Cementation: continuously or discontinuously weakly silica and calcium carbonate cemented with 20 to 50 percent strong silica and calcium carbonate cementation occurring as concretions, durinodes, or lenses within the matrix. These are hard or very hard when dry, and brittle when moist, and do not slake in dilute hydrochloric acid.

Additional features: Some pedons have weakly silica cemented stratified C horizons below the Bqk horizon

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and few fine vesicular pores; 20 percent gravel; noneffervescent; neutral (pH 7.1); clear smooth boundary.

Bt—3 to 9 inches; light brown (7.5YR 6/4) gravelly sandy clay loam; brown (7.5YR 4/4) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and few fine roots; common very fine and fine tubular pores; many faint clay films bridging sand grains and lining pores; 25 percent gravel, 5 percent cobble; noneffervescent; neutral (pH 7.1); clear wavy boundary.

Btk—9 to 15 inches; light brown (7.5YR 6/4) very cobbly sandy clay loam; brown (7.5YR 4/4) moist; weak medium and fine subangular blocky structure; hard, friable, moderately sticky and moderately plastic; common very fine and few fine roots; common very fine and few fine tubular pores; many faint clay films bridging sand grains and lining pores; 35 percent gravel, 20 percent cobble; strongly effervescent; moderately alkaline (pH 8.0); abrupt wavy boundary.

R—15 inches; hard, fractured, slightly weathered calcareous sandstone and chert bedrock.

Range in Characteristics

Clay content (control section): 20 to 35 percent
Rock fragment content (control section): 40 to 80 percent

Reaction: neutral to moderately alkaline

Depth to argillic horizon: 2 to 5 inches

Depth to carbonates: 5 to 14 inches

A horizon

Hue: 5YR, 7.5YR

Value: 5 or 6 dry, 3 or 4 moist

Chroma: 2 through 4, dry or moist

Bt and Btk horizon

Hue: 5YR, 7.5YR

Value: 5 or 6 dry, 3 or 4 moist

Chroma: 3 or 4, dry or moist

Rock fragments: 20 to 35 percent gravel, 5 to 45 percent cobbles, and 0 to 45 percent stones

Effervescence: noneffervescent to slightly effervescent (Bt horizon)

Slightly to violently effervescent (Btk horizon)

Calcium carbonate equivalent: 2 to 15 percent

Some pedons developed in chert, cherty limestone, or cherty sandstone residuum do not have a Btk horizon.

Some pedons have a discontinuous, 1-cm to 3-cm thick, fractured, non-root restrictive, weakly to strongly calcium carbonate cemented laminar pan overlying

limestone or calcareous fine-grained sandstone bedrock.

Some Btk horizons are weakly cemented with calcium carbonate but do not meet the thickness requirement for a calcic horizon.

98—Puertecito family, 15 to 35 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 6,400 to 7,000 feet (1,950 to 2,134 meters)

Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)

Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)

Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)

Frost-free period: 145 to 160 days

Map Unit Composition

Puertecito family and similar soils: 80 percent

Minor components: 20 percent

- Soils that have petrocalcic horizons
- Soils in drainageways that are occasionally flooded
- Soils that are deeper than 20 inches to bedrock
- Soils that have no accumulation of calcium carbonate in the profile
- Soils that have larger amounts of clay in the profile

Properties and Qualities

Puertecito family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Ustic Haplargids

Geomorphic position: side slopes of hills and ridges

Parent material: residuum weathered from cherty limestone

Slope: 15 to 35 percent

Surface fragments: about 15 percent cobbles, about 50 percent gravel, about 5 percent stones

Depth to restrictive feature: 10 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 1.2

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Limestone Hills 10-14" p.z.

Ecosystem site number: 035XC308AZ

Present native vegetation: muttongrass, Wyoming big sagebrush, blue grama, Stansbury cliffrose, Utah juniper, green Mormon tea

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Marble Platform; 1.57 miles west of Cedar Mountain; 36 degrees, 3 minutes, 34 seconds north latitude; 111 degrees, 47 minutes, 57 seconds west longitude.

A—0 to 4 inches; light brown (7.5YR 6/3) very cobbly loam; brown (7.5YR 4/3) moist; weak moderately thick platy structure parting to moderate very fine subangular blocky; soft, very friable, slightly sticky and nonplastic; common very fine roots; few very fine and fine vesicular and common very fine tubular pores; 20 percent gravel, 25 percent cobble, 5 percent stone; noneffervescent; moderately alkaline (pH 8.0); clear smooth boundary.

Bt—4 to 11 inches; light brown (7.5YR 6/3) very cobbly loam; brown (7.5YR 4/3) moist; moderate fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine and few medium roots; common very fine and few fine tubular pores; many faint clay films bridging sand grains and lining pores; 25 percent gravel, 30 percent cobble; slightly effervescent; moderately alkaline (pH 8.0); clear wavy boundary.

Btk—11 to 15 inches; light brown (7.5YR 6/3) extremely cobbly loam; brown (7.5YR 4/3) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine through medium roots; few very fine and fine tubular pores; common faint clay films bridging sand grains; 25 percent gravel, 45 percent cobble; rock fragments are moderately to slightly weathered and slightly displaced from bedrock with horizontal orientation; violently effervescent; moderately alkaline (pH 8.4); abrupt wavy boundary.

R—15 inches; hard, slightly weathered limestone bedrock.

Range in Characteristics

Clay content (control section): 20 to 35 percent
Rock fragment content (control section): 45 to 80 percent

Reaction: neutral to moderately alkaline
Depth to argillic horizon: 2 to 4 inches

Depth to carbonates: 6 to 13 inches (Btk horizon)

A horizon

Value: 5 or 6 dry

Effervescence: noneffervescent to slightly effervescent

Bt and Btk horizons

Value: 5 or 6 dry, 3 or 4 moist

Chroma: 3 or 4, dry or moist

Rock fragments: 20 to 25 percent gravel, 15 to 55 percent cobbles, and 0 to 20 percent stones

Effervescence: noneffervescent to violently effervescent

Calcium carbonate equivalent: 0 to 15 percent

Some pedons developed in chert, cherty limestone, or cherty sandstone residuum do not have a Btk horizon.

Some Btk horizons are weakly cemented with calcium carbonate but do not meet the thickness requirement for a calcic horizon.

99—Puertecito-Meriwhitica-Progresso families complex, 2 to 8 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,500 to 7,000 feet (1,372 to 2,134 meters)

Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)

Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)

Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)

Frost-free period: 145 to 160 days

Map Unit Composition

Puertecito family and similar soils: 45 percent

Meriwhitica family and similar soils: 35 percent

Progresso family and similar soils: 15 percent

Minor components: 5 percent

- Soils that have petrocalcic horizons
- Soils in drainageways that are occasionally flooded
- Soils that are deep to bedrock
- Soils that have no accumulation of calcium carbonate in the profile

Properties and Qualities

Puertecito family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Ustic Haplargids

Geomorphic position: side slopes of hills and ridges

Parent material: residuum weathered from calcareous sandstone

Slope: 2 to 8 percent

Surface fragments: about 2 percent stones, about 3 percent cobbles, about 25 percent gravel

Depth to restrictive feature: 10 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 1.3

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Medium

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Limy Upland 10-14" p.z.

Ecosystem site number: 035XC311AZ

Present native vegetation: needleandthread, Indian ricegrass, Nevada Mormon tea, Wyoming big sagebrush, black grama, blue grama, fourwing saltbush

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Marble Platform; 4,697 feet east of Peshlakai Point; 36 degrees, 9 minutes, 12 seconds north latitude; 111 degrees, 46 minutes, 58 seconds west longitude.

A—0 to 2 inches; light brown (7.5YR 6/4) gravelly fine sandy loam; brown (7.5YR 5/4) moist; moderate thin platy structure parting to moderate very fine and fine subangular blocky; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; common very fine vesicular and few very fine tubular pores; 20 percent gravel, 2 percent cobble; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bt—2 to 10 inches; light brown (7.5YR 6/4) very cobbly loam; brown (7.5YR 5/4) moist; weak medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine tubular pores; common thin clay films bridging sand grains and lining pores; 15 percent gravel, 20 percent cobble, and 5 percent stone; violently effervescent; strongly alkaline (pH 8.6); clear wavy boundary.

Btk—10 to 15 inches; pink (7.5YR 7/4) very cobbly very fine sandy loam; light brown (7.5YR 6/4) moist; weak medium and fine subangular blocky structure;

slightly hard, very friable, nonsticky and slightly plastic; common very fine and few fine roots; common very fine and few fine tubular pores; few thin clay films bridging sand grains and lining pores; common medium soft seams of calcium carbonate; 15 percent gravel, 25 percent cobble, and 5 percent stone; violently effervescent; strongly alkaline (pH 8.6); abrupt wavy boundary.

R—15 inches; limestone bedrock.

Range in Characteristics

Clay content (control section): 18 to 20 percent

Rock fragment content (control section): 35 to 55 percent

Reaction: slightly to moderately alkaline

Depth to argillic horizon: 2 to 5 inches

Depth to carbonates: 4 to 11 inches

Depth to bedrock: 10 to 20 inches

A horizon

Value: 5 or 6 dry, 4 or 5 moist

Chroma: 3 or 4, dry or moist

Bt and Btk horizon

Hue: 5YR, 7.5YR

Value: 5 or 6 dry, 3 through 5 moist

Chroma: 3 or 4, dry or moist

Effervescence: strongly to violently effervescent

Calcium carbonate equivalent: 0 to 15 percent

Some pedons have a discontinuous, 1-cm to 3-cm thick, fractured, non-root restrictive, weakly to strongly calcium carbonate cemented laminar pan overlying limestone or calcareous fine-grained sandstone bedrock.

Some Btk horizons are weakly cemented with calcium carbonate but do not meet the thickness requirement for a calcic horizon.

Meriwhitica family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, calcareous, mesic Lithic Ustic Torriorthents

Geomorphic position: pockets and ledges on ridges and escarpments

Parent material: colluvium and/or residuum weathered from limestone

Slope: 2 to 8 percent

Surface fragments: about 15 percent coarse gravel, about 30 percent cobbles, about 5 percent stones

Depth to restrictive feature: 9 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 0.8
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: very high
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-3
Ecological site name: Limestone Hills 10-14" p.z.
Ecosystem site number: 035XC308AZ
Present native vegetation: muttongrass, Wyoming big sagebrush, blue grama, Stansbury cliffrose, Utah juniper, green Mormon tea
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Marble Platform; 5,268 feet northeast of Palisades of the Desert; 36 degrees, 5 minutes, 54 seconds north latitude; 111 degrees, 46 minutes, 32 seconds west longitude.

A2—0 to 1 inch; brown (7.5YR 5/3) extremely gravelly very fine sandy loam; dark brown (7.5YR 3/3) moist; moderate fine subangular blocky structure parting to granular; soft, very friable, slightly sticky and slightly plastic, many very fine roots; common very fine interstitial pores; 65 percent gravel, 10 percent cobble; strongly effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

A2—1 to 4 inches; light brown (7.5YR 6/4) very gravelly very fine sandy loam; brown (7.5YR 4/4) moist; moderate fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine and few fine and medium roots; common very fine and few fine irregular and tubular pores; 35 percent gravel, 5 percent cobble; violently effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

C—4 to 9 inches; light brown (7.5YR 6/4) very cobbly very fine sandy loam; brown (7.5YR 5/4) moist; moderate fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine and few fine and medium roots; common very fine and few fine irregular and tubular pores; 15 percent gravel, 30 percent cobble, 5 percent stone; violently effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

R—9 inches; limestone bedrock.

Range in Characteristics

Depth to bedrock: 9 to 20 inches
 Clay content: averages 12 to 18 percent

Rock fragments: average 35 to 75 percent gravel, cobble, and stone

A horizon

Hue: 7.5YR, 10YR
 Value: 5 or 6 dry, 3 through 5 moist
 Chroma: 3 or 4, dry or moist
 Calcium carbonate equivalent: 5 to 20 percent

Bk horizons

Hue: 7.5YR, 10YR
 Value: 5 or 6 dry, 4 or 5 moist
 Calcium carbonate equivalent: 15 to 25 percent

Progreso family soils

Taxonomic classification: Fine-loamy, mixed, superactive, mesic Ustic Calciargids
Geomorphic position: side slopes of hills and ridges
Parent material: residuum weathered from cherty limestone
Slope: 2 to 8 percent
Surface fragments: about 30 percent gravel, about 5 percent cobbles
Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)
Drainage class: Well drained
Permeability: about 4.00 in/hr (moderately rapid)
Available water capacity total inches: 2.8
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: Medium
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-3
Ecological site name: Loamy Upland 10-14" p.z.
Ecosystem site number: 035XC313AZ
Present native vegetation: Wyoming big sagebrush, blue grama, galleta, Nevada Mormon tea, Opuntia, bottlebrush squirreltail
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Marble Platform; 1.28 miles southwest of Gold Hill; 36 degrees, 7 minutes, 8 seconds north latitude; 111 degrees, 45 minutes, 47 seconds west longitude.

A—0 to 2 inches; strong brown (7.5YR 5/6) gravelly sandy loam; strong brown (7.5YR 4/6) moist; moderate fine subangular blocky structure parting to moderate very fine and fine subangular blocky; soft, very friable, nonsticky and slightly plastic; common very fine and

Taxonomic Unit Description

Type Location: about 1,580 feet south and 2,200 feet west of the northeast corner of section 16, township 40 north, range 10 west; 36 degrees, 52 minutes, 15.9 seconds north latitude; 113 degrees, 22 minutes, 35.5 seconds west longitude.

A—0 to 2 inches; reddish yellow (5YR 6/6) fine sandy loam, yellowish red (5YR 4/6) moist; weak thin platy and weak fine granular structure; slightly hard, very friable, nonsticky and nonplastic; many fine and very fine roots; many very fine irregular and common fine tubular pores; 5 percent gravel; strongly effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bw—2 to 8 inches; reddish yellow (5YR 6/6) loam, yellowish red (5YR 4/6) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; common fine and very fine tubular and irregular pores; 5 percent gravel; strongly effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Byk1—8 to 20 inches; pink (5YR 7/4) loam, light reddish brown (5YR 6/4) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; many fine and very fine roots; common fine and very fine tubular and irregular pores; 5 percent gravel; 5 percent gypsum crystals; strongly effervescent, 12 percent calcium carbonate equivalent; slightly alkaline (pH 7.8); clear smooth boundary.

Byk2—20 to 32 inches; reddish yellow (5YR 7/6) sandy loam, yellowish red (5YR 5/6) moist; massive; soft, very friable, nonsticky and nonplastic; common fine and very fine roots; common fine and very fine tubular pores; 5 percent gravel; 10 percent gypsum crystals; strongly effervescent, 10 percent calcium carbonate equivalent; slightly alkaline (pH 7.8); clear smooth boundary.

Byk3—32 to 44 inches; reddish yellow (5YR 7/6) loam, yellowish red (5YR 5/6) moist; massive; soft, very friable, slightly sticky and nonplastic; common fine and very fine roots; common fine and very fine tubular pores; 10 percent gravel; 5 percent gypsum crystals; strongly effervescent, 10 percent calcium carbonate equivalent; slightly alkaline (pH 7.8); clear smooth boundary.

Byk4—44 to 55 inches; pink (5YR 7/4) sandy loam, reddish yellow (5YR 6/6) moist; massive; soft, very friable, nonsticky and nonplastic; few fine and very fine roots; common fine and very fine tubular pores; 10 percent gravel; 10 percent gypsum crystals; strongly

effervescent; slightly alkaline (pH 7.8); abrupt smooth boundary.

Byk5—55 to 60 inches; pink (5YR 7/4) gravelly loamy sand, reddish yellow (5YR 6/6) moist; single grain; loose; few fine and very fine roots; common fine and very fine tubular pores; 15 percent gravel; 10 percent gypsum crystals; strongly effervescent; slightly alkaline (pH 7.8).

Range in Characteristics

Depth to gypsic horizon: 8 to 20 inches
Rock fragments: average 2 to 15 percent

A horizon

Value: 5 or 6 dry, 3 or 4 moist
Chroma: 4 through 6, dry or moist

Bw horizon

Value: 5 or 6 dry, 4 or 5 moist
Chroma: 4 through 6, dry or moist
Gypsum: 0 to 5 percent
Calcium carbonate equivalent: less than 5 percent

By horizon

Value: 5 through 7 dry, 4 through 6 moist
Chroma: 4 through 6, dry or moist
Gypsum: 10 to 20 percent
Calcium carbonate equivalent: 10 to 20 percent

101—Rock outcrop-Akela family complex, 15 to 60 percent slopes

Map Unit Setting

Landform: plateau
Elevation: 1,600 to 2,000 feet (488 to 610 meters)
Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)
Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)
Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)
Frost-free period: 200 to 240 days

Map Unit Composition

Rock outcrop: 45 percent
Akela family and similar soils: 40 percent
Minor components: 15 percent

- Soils that have accumulation of calcium carbonate in the profile
- Soils that are deep or very deep to bedrock
- Skree slopes which are devoid of vegetation

- Soils that have an accumulation of clay in the profile

Properties and Qualities

Rock outcrop

Vertical cliffs of canyons in the Vishnu Schist and Zoroaster Granite

Akela family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, calcareous, thermic Lithic Torriorthents

Geomorphic position: pockets and ledges on vertical cliffs

Parent material: colluvium derived from schist and/or colluvium derived from granite and/or eolian deposits derived from limestone and sandstone

Slope: 15 to 60 percent

Surface fragments: about 15 percent gravel, about 10 percent cobbles, about 20 percent stones

Depth to restrictive feature: 8 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 1.4

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Schist Hills 6-10" p.z.

Ecosystem site number: 035XE504AZ

Present native vegetation: ephedra, big galleta, catclaw acacia, Opuntia, desert brickellbush

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 1,252 feet southwest of Monument Creek; 36 degrees, 5 minutes, 42 seconds north latitude; 112 degrees, 11 minutes, 5 seconds west longitude.

A—0 to 2 inches; brown (10YR 5/3) very stony very fine sandy loam; dark brown (10YR 3/3) moist; weak thin platy structure; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine irregular pores; 15 percent gravel, 10 percent cobble, and 20 percent stone; slightly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

Bw—2 to 6 inches; yellowish brown (10YR 5/4) very cobbly sandy loam; brown (10YR 4/3) moist; weak fine

and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and few fine roots; few fine tubular pores; 20 percent gravel, 10 percent cobble, and 10 percent stone; strongly effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bk—6 to 17 inches; light brown (7.5YR 6/4) very cobbly silt loam; strong brown (7.5YR 4/6) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine and common fine roots; common very fine tubular pores; few fine seams of calcium carbonate; 10 percent gravel, 10 percent cobble, and 10 percent stone; violently effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

R—17 inches; granite and schist bedrock.

Range in Characteristics

Rock fragments: average more than 35 percent in the control section. A surface lag layer containing 40 to 60 percent gravel and 5 to 20 percent cobble is common.

Depth to unweathered bedrock: 8 to 20 inches

Reaction: slightly to moderately alkaline

Clay content: averages 5 to 18 percent

A horizon

Hue: 7.5YR, 10YR

Value: 4, 5 or 6 dry, 3 or 4 moist

Chroma: 3 or 4, dry or moist

B horizons

Hue: 7.5YR, 10YR

Value: 4 or 5 dry, 3 or 4 moist

Chroma: 3 or 4 dry, 2, 3 or 4 moist

Some pedons contain a layer of weathered bedrock less than 3 inches thick above the lithic contact.

102—Rock outcrop-Cellar family complex, 15 to 60 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,500 to 4,500 feet (1,067 to 1,372 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 200 to 240 days

Map Unit Composition

Rock outcrop: 75 percent
 Cellar family and similar soils: 15 percent
 Minor components: 10 percent

- Soils that are deep to bedrock
- Soils that have accumulation of calcium carbonate in the profile
- Talus slopes devoid of vegetation

Properties and Qualities

Rock outcrop

Pediments of the Hakatai Shale

Cellar family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, nonacid, thermic Lithic Torriorthents
Geomorphic position: pockets and ledges on steep pediments
Parent material: colluvium derived from sandstone and shale
Slope: 15 to 60 percent
Surface fragments: about 50 percent coarse gravel, about 10 percent cobbles, about 20 percent stones
Depth to restrictive feature: 4 to 12 inches to bedrock (lithic)
Drainage class: Excessively drained
Permeability: about 13.00 in/hr (rapid)
Available water capacity total inches: 0.5
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: very high
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-5
Ecological site name: Channery Hills 6-10" p.z.
Ecosystem site number: 035XE502AZ
Present native vegetation: Torrey Mormon tea, shadscale saltbush, white brittlebush
Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Tonto Platform; 1,938 feet east of Bright Angel Creek; 36 degrees, 5 minutes, 48 seconds north latitude; 112 degrees, 5 minutes, 10 seconds west longitude.

A—0 to 2 inches; brown (7.5YR 5/4) extremely gravelly loamy sand; brown (7.5YR 4/3) moist; weak fine subangular blocky structure; soft; very friable, nonsticky and nonplastic; few very fine and fine roots; common very fine and fine irregular pores; 65 percent

gravel; noneffervescent; slightly alkaline (pH 7.6); abrupt smooth boundary.

C—2 to 9 inches; light brown (7.5YR 6/4) extremely gravelly loamy sand; brown (7.5YR 5/4) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine irregular pores; 65 percent gravel; noneffervescent; slightly alkaline (pH 7.6); abrupt wavy boundary.

R—9 inches; Hakatai Formation sandstone bedrock.

Range in Characteristics

Rock fragments: 35 to 70 percent, dominantly gravel but some pedons contain mostly cobble or stones
 Clay content: 5 to 10 percent in the control section
 Depth to bedrock: 4 to 12 inches
 Reaction: Slightly acid to moderately alkaline
 Calcium carbonate: Noneffervescent above the lithic contact or to a depth of more than 10 inches

A horizon

Hue: 10YR, 7.5YR
 Value: 5 or 6 dry, 3, 4 or 5 moist
 Chroma: 3, 4, or 5 dry, 3 through 6 moist
 Organic matter: Less than 1 percent

B or C horizons

Hue: 10YR, 7.5YR
 Value: 4, 5 or 6 dry, 3 through 5 moist
 Chroma: 3 through 6, dry or moist

103—Rock outcrop-Lithic Torriorthents complex, 15 to 60 percent slopes

Map Unit Setting

Landform: plateau
Elevation: 1,200 to 1,600 feet (366 to 488 meters)
Mean annual precipitation: 3 to 6 inches (76 to 152 millimeters)
Mean annual air temperature: 70 to 75 degrees F (21 to 24 degrees C)
Mean annual soil temperature: 72 to 77 degrees F (23 to 26 degrees C)
Frost-free period: 300 to 360 days

Map Unit Composition

Rock outcrop: 70 percent
 Lithic Torriorthents and similar soils: 30 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major

components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Rock outcrop

Very steep and slick sidewalls of Precambrian metamorphic rocks in entrenched canyons and gorges

Lithic Torriorthents soils

Taxonomic classification: Lithic Torriorthents

Geomorphic position: pockets, ledges, and crevices

Parent material: colluvium derived from schist and/or sandy eolian deposits derived from mixed

Slope: 15 to 60 percent

Depth to restrictive feature: 8 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 30

Land Resource Unit: 30-1

Ecological site name: Granitic Hills 3-6" p.z.

Ecosystem site number: 030XA104AZ

Present native vegetation: creosotebush, white brittlebush, white bursage, Opuntia

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 1,213 feet north of Devils Slide Rapids, 35 degrees, 56 minutes, 0 seconds north latitude; 113 degrees, 42 minutes, 50 seconds west longitude.

A—0 to 1 inch; light yellowish brown (10YR 6/4) extremely cobbly sandy loam; dark yellowish brown (10YR 4/4) moist; moderate thin platy structure parting to moderate very fine subangular blocky; soft, very friable, nonsticky and nonplastic; few very fine roots; common very fine vesicular pores; 25 percent gravel, 30 percent cobble, and 5 percent stone; noneffervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

Bw1—1 to 4 inches; light yellowish brown (10YR 6/4) very gravelly sandy loam; dark yellowish brown (10YR 4/4) moist; moderate very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; few fine tubular pores; 40 percent gravel, 5 percent cobble; slightly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

Bw2—4 to 6 inches; light brown (7.5YR 6/4) very gravelly sandy loam; brown (7.5YR 4/4) moist;

moderate very fine subangular blocky structure; soft, very friable, slightly sticky and nonplastic; common very fine and fine roots; 45 percent gravel; few fine tubular pores; slightly effervescent; moderately alkaline (pH 8.2).

R—6 inches; slightly weathered granite bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

104—Rock outcrop-Lithic Torriorthents complex, Cardenas Formation, 15 to 60 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,500 to 4,500 feet (1,067 to 1,372 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 200 to 240 days

Map Unit Composition

Rock outcrop: 70 percent

Lithic Torriorthents and similar soils: 30 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Rock outcrop

Steep pediments and old lava flows

Lithic Torriorthents soils

Taxonomic classification: Lithic Torriorthents

Geomorphic position: pockets and ledges

Parent material: colluvium and/or residuum weathered from basalt

Slope: 15 to 60 percent

Depth to restrictive feature: 3 to 15 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Basalt Hills 6-10" p.z.

Ecosystem site number: 035XE501AZ

Present native vegetation: ephedra, catclaw acacia, blue threeawn, rayless brittlebush, Ferocactus

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 36 degrees, 6 minutes, 28 seconds north latitude; 111 degrees, 49 minutes, 55 seconds west longitude.

C—0 to 6 inches; brown (7.5YR 5/4) extremely gravelly loamy fine sand; brown (7.5YR 4/4) moist; single grain; loose, nonsticky and nonplastic; common very fine roots; many very fine irregular pores; 60 percent gravel; strongly effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

R—6 inches; basalt bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

105—Rock outcrop-Lithic Torriorthents complex, Hakatai Formation, 15 to 60 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,500 to 4,500 feet (1,067 to 1,372 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 200 to 240 days

Map Unit Composition

Rock outcrop: 80 percent

Lithic Torriorthents and similar soils: 20 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Rock outcrop

Lithic Torriorthents

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

106—Rock outcrop-Lithic Torriorthents complex, Kaibab, Toroweap, and Coconino Formations, 15 to 60 percent slopes

Map Unit Setting

Landform: plateau
Elevation: 3,200 to 5,800 feet (976 to 1,768 meters)
Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)
Mean annual air temperature: 55 to 57 degrees F (13 to 14 degrees C)
Mean annual soil temperature: 57 to 59 degrees F (15 to 16 degrees C)
Frost-free period: 160 to 175 days

Map Unit Composition

Rock outcrop: 60 percent
 Lithic Torriorthents and similar soils: 40 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Rock outcrop

Tall vertical cliffs and escarpments of the Kaibab, Toroweap, and Coconino Formations

Lithic Torriorthents soils

Taxonomic classification: Lithic Torriorthents
Geomorphic position: colluvial slopes and pockets on

ledges of plateau escarpments and canyon sidewalls

Parent material: colluvium derived from limestone, sandstone, and shale

Slope: 15 to 60 percent

Depth to restrictive feature: 3 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-2

Ecological site name: Breaks 6-10" p.z.

Ecosystem site number: 035XB201AZ

Present native vegetation: Torrey Mormon tea, shadscale saltbush, Sporobolus, beavertail pricklypear, bush muhly

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 3,285 feet north of Cathedral Wash; 36 degrees, 50 minutes, 50 seconds north latitude; 111 degrees, 36 minutes, 53 seconds west longitude.

A—0 to 2 inches; yellowish brown (10YR 5/4) extremely gravelly sandy loam; dark yellowish brown (10YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine through coarse roots; common fine irregular pores; 40 percent gravel, 20 percent cobble, and 5 percent stone; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

C—2 to 9 inches; yellowish brown (10YR 5/4) extremely gravelly sandy loam; dark yellowish brown (10YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; common fine through coarse roots; few fine tubular pores; 40 percent gravel, 20 percent cobble, and 5 percent stone; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

R—9 inches; limestone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined.

Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

107—Rock outcrop-Lithic Torriorthents complex, Moenkopi, Kaibab, and Toroweap Formations, 15 to 60 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,200 to 3,500 feet (976 to 1,067 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 55 to 57 degrees F (13 to 14 degrees C)

Mean annual soil temperature: 57 to 59 degrees F (15 to 16 degrees C)

Frost-free period: 160 to 175 days

Map Unit Composition

Rock outcrop: 70 percent

Lithic Torriorthents and similar soils: 30 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Rock outcrop

Tall, vertical cliffs and escarpments of the Moenkopi, Kaibab, and Toroweap Formations

Lithic Torriorthents soils

Taxonomic classification: Lithic Torriorthents

Geomorphic position: colluvial slopes and pockets on ledges of plateau escarpments and canyon sidewalls

Parent material: colluvium derived from limestone, sandstone, and shale

Slope: 15 to 60 percent

Depth to restrictive feature: 3 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-2

Ecological site name: Breaks 6-10" p.z.

Ecosystem site number: 035XB201AZ

Present native vegetation: Torrey Mormon tea, shadscale saltbush, Sporobolus, beavertail pricklypear, bush muhly

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 2,904 feet south of Paria River; 36 degrees, 51 minutes, 3 seconds north latitude; 111 degrees, 36 minutes, 8 seconds west longitude.

A—0 to 1 inch; brown (7.5YR 5/4) extremely gravelly sandy loam; brown (7.5YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine irregular pores; 55 percent gravel, 5 percent cobble, and 5 percent stone; violently effervescent; strongly alkaline (pH 8.6); abrupt smooth boundary.

C—1 to 8 inches; light brown (7.5YR 6/4) extremely gravelly sandy loam; brown (7.5YR 5/4) moist; massive; soft, very friable, nonsticky and nonplastic; common fine and medium and few coarse roots; few fine tubular pores; 55 percent gravel, 5 percent cobble, and 5 percent stone; violently effervescent; strongly alkaline (pH 8.6); abrupt irregular boundary.

2R—8 inches; limestone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

108—Rock outcrop-Lithic Torriorthents complex, Nankoweap Formation, 2 to 8 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,500 to 4,500 feet (1,067 to 1,372 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 200 to 240 days

Map Unit Composition

Rock outcrop: 70 percent

Lithic Torriorthents and similar soils: 30 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Rock outcrop

Vertical cliffs and pediments

Lithic Torriorthents soils

Taxonomic classification: Lithic Torriorthents

Geomorphic position: pockets and concavities on ledges and pediments

Parent material: colluvium derived from limestone and sandstone

Slope: 2 to 8 percent

Depth to restrictive feature: 4 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Upland, Shallow 6-10" p.z.

Ecosystem site number: 035XE519AZ

Present native vegetation: blackbrush, ephedra, Opuntia, banana yucca

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In Chuar Valley; 2,102 feet north of Tanner Canyon Rapids; 36 degrees, 6 minutes, 28 seconds north latitude; 111 degrees, 50 minutes, 5 seconds west longitude.

A—0 to 6 inches; brown (7.5YR 5/4) very gravelly sandy clay loam; brown (7.5YR 4/4) moist; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots, few fine tubular pores; 50 percent gravel; strongly effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

R—6 inches; sandstone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

109—Rock outcrop-Lithic Torriorthents complex, Supai Group, 15 to 60 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,425 to 5,160 feet (1,042 to 3,425 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 55 to 57 degrees F (13 to 14 degrees C)

Mean annual soil temperature: 57 to 59 degrees F (15 to 16 degrees C)

Frost-free period: 160 to 175 days

Map Unit Composition

Rock outcrop: 60 percent

Lithic Torriorthents and similar soils: 40 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Rock outcrop

Horizontal ledges on escarpments of the Supai Group

Lithic Torriorthents soils

Taxonomic classification: Lithic Torriorthents

Geomorphic position: pockets on ledges

Parent material: colluvium derived from calcareous sandstone

Slope: 15 to 60 percent

Depth to restrictive feature: 3 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-2

Ecological site name: Breaks 6-10" p.z.

Ecosystem site number: 035XB201AZ

Present native vegetation: Torrey Mormon tea, shadscale saltbush, Sporobolus, beavertail pricklypear, bush muhly

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 36 degrees, 37 minutes, 56 seconds north latitude; 111 degrees, 45 minutes, 53 seconds west longitude.

C—0 to 5 inches; reddish brown (5YR 5/4) extremely gravelly loamy coarse sand; reddish brown (5YR 4/4) moist; single grain; loose, nonsticky and nonplastic; common very fine roots; common fine irregular pores; 50 percent gravel, 5 percent cobble, and 10 percent stone; violently effervescent, moderately alkaline (pH 8.2); abrupt irregular boundary.

R—5 inches; sandstone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

110—Rock outcrop-Lithic Torriorthents complex, Vishnu Schist Formation, 15 to 60 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 1,600 to 2,000 feet (488 to 610 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 200 to 240 days

Map Unit Composition

Rock outcrop: 60 percent

Lithic Torriorthents and similar soils: 40 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Rock outcrop

Very steep to vertical canyon side walls composed of the Vishnu Schist and Zoroaster granite

Lithic Torriorthents soils

Taxonomic classification: Lithic Torriorthents

Geomorphic position: pockets and concavities in canyon side walls

Parent material: colluvium derived from mica schist and/or eolian sands

Slope: 15 to 60 percent

Depth to restrictive feature: 8 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Schist Hills 6-10" p.z.

Ecosystem site number: 035XE504AZ

Present native vegetation: ephedra, big galleta, catclaw acacia, Opuntia, desert brickellbush

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 36 degrees, 5 minutes, 42 seconds north latitude; 112 degrees, 11 minutes, 5 seconds west longitude.

A—0 to 2 inches; brown (10YR 5/3) very stony very fine sandy loam; dark brown (10YR 3/3) moist; weak thin platy structure; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine irregular pores; 10 percent fine gravel, 5 percent medium and coarse gravel, 10 percent cobble, and 20 percent stone; slightly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

Bw—2 to 6 inches; yellowish brown (10YR 5/4) very gravelly sandy loam; brown (10YR 4/3) moist; weak fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and few fine roots; few fine tubular pores; 5 percent fine gravel, 15 percent medium and coarse gravel, 10 percent cobble, and 10 percent stone;

strongly effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bk—6 to 17 inches; light brown (7.5YR 6/4) very cobbly silt loam; strong brown (7.5YR 4/6) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine and common fine roots; common very fine tubular pores; few fine seams of calcium carbonate; 10 percent medium and coarse gravel, 10 percent cobble, and 10 percent stone; violently effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

R—17 inches; schist bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

111—Rock outcrop-Lithic Ustic Torriorthents complex, Esplanade Formation, 2 to 8 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,500 to 5,500 feet (1,372 to 1,676 meters)

Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)

Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)

Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)

Frost-free period: 145 to 175 days

Map Unit Composition

Rock outcrop: 60 percent

Lithic Ustic Torriorthents and similar soils: 40 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major

components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Rock outcrop

Nearly flat sandstone pediments of calcareous sandstone of the Esplanade Formation

Lithic Ustic Torriorthents soils

Taxonomic classification: Lithic Ustic Torriorthents

Geomorphic position: Concavities and depressions in calcareous sandstone

Parent material: colluvium derived from calcareous sandstone and/or eolian deposits derived from calcareous sandstone and/or residuum weathered from calcareous sandstone

Slope: 2 to 8 percent

Depth to restrictive feature: 3 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Sandstone Upland 10-14" p.z.

Ecosystem site number: 035XE310AZ

Present native vegetation: desert needlegrass, Bigelow sagebrush, ephedra, galleta, turbinella oak, other evergreen trees

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Esplanade; 4,854 feet northeast of Saddle Horse Spring; 36 degrees, 14 minutes, 12 seconds north latitude; 113 degrees, 2 minutes, 30 seconds west longitude.

A—0 to 2 inches; reddish brown (5YR 5/4) very gravelly sandy loam; reddish brown (5YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; common very fine and fine irregular pores; 40 percent gravel; slightly effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

C—2 to 6 inches; reddish brown (5YR 5/4) very gravelly sandy loam; reddish brown (5YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; common very fine and fine

irregular pores; 50 percent gravel; strongly effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

R—6 inches; Esplanade sandstone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

112—Rock outcrop-Lithic Ustic Torriorthents-Ustic Haplocalcids complex, Tonto Group and Redwall Formation, 30 to 60 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,500 to 6,000 feet (1,372 to 1,829 meters)

Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)

Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)

Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)

Frost-free period: 145 to 160 days

Map Unit Composition

Rock outcrop: 45 percent

Lithic Ustic Torriorthents and similar soils: 35 percent

Ustic Haplocalcids and similar soils: 20 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Rock outcrop

Tall, vertical cliffs and escarpments

Lithic Ustic Torriorthents soils

Taxonomic classification: Lithic Ustic Torriorthents

Geomorphic position: colluvial slopes on ledges of canyon sidewalls

Parent material: colluvium and/or residuum weathered from limestone

Slope: 30 to 60 percent

Depth to restrictive feature: 10 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Sedimentary Cliffs 10-14" p.z.

Ecosystem site number: 035XC302AZ

Present native vegetation: other evergreen trees, pointleaf manzanita, turbinella oak, Wyoming big sagebrush, skunkbush sumac, spiny greasewood

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Tonto Platform; 1,343 feet southwest of Bright Angel Trail; 36 degrees, 3 minutes, 57 seconds north latitude; 112 degrees, 8 minutes, 3 seconds west longitude.

A—0 to 2 inches; brown (7.5YR 5/4) extremely stony loam; brown (7.5YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine tubular pores; 15 percent gravel, 20 percent cobble, and 30 percent stone; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bw—2 to 7 inches; light brown (7.5YR 6/4) extremely gravelly loam; brown (7.5YR 5/4) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine and medium roots; common very fine and fine tubular pores; 40 percent gravel, 20 percent cobble, and 10 percent stone; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

2Bk—7 to 17 inches; light brown (7.5YR 6/4) extremely cobbly loam; brown (7.5YR 5/4) moist; massive; soft, very friable, slightly sticky and slightly plastic; common fine and medium roots; common fine and medium tubular pores; calcium carbonate is disseminated throughout; 15 percent gravel; 30 percent cobble, and 10 percent stone; violently effervescent; moderately alkaline (pH 8.4); abrupt wavy boundary.

3R—17 inches; fractured limestone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access,

statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Ustic Haplocalcids soils

Taxonomic classification: Ustic Haplocalcids

Geomorphic position: colluvial slopes on ledges of canyon sidewalls

Parent material: colluvium and/or residuum weathered from limestone

Slope: 30 to 60 percent

Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Sedimentary Cliffs 10-14" p.z.

Ecosystem site number: 035XC302AZ

Present native vegetation: other evergreen trees, pointleaf manzanita, turbinella oak, Wyoming big sagebrush, skunkbush sumac, spiny greasewood

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Tonto Platform; 36 degrees, 3 minutes, 59 seconds north latitude; 112 degrees, 8 minutes, 5 seconds west longitude.

A—0 to 4 inches; brown (7.5YR 5/4) extremely stony fine sandy loam; brown (7.5YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and common medium roots; many very fine and fine tubular pores; 25 percent gravel, 10 percent cobble, and 30 percent stone; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bk1—4 to 13 inches; pink (5YR 7/4) very gravelly fine sandy loam; light reddish brown (5YR 6/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and medium and few coarse roots; few fine and medium tubular pores; common fine soft masses of calcium carbonate; common moderately thick calcium carbonate coats and pendants on the undersides and sides of rock fragments; 40 percent gravel, 5 percent cobble;

violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bk2—13 to 32 inches; light reddish brown (5YR 6/4) very gravelly fine sandy loam; reddish brown (5YR 5/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and medium and few coarse roots; few fine and medium tubular pores; common fine soft masses of calcium carbonate; common moderately thick calcium carbonate coats and pendants on the undersides and sides of rock fragments; 40 percent gravel, 5 percent cobble; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

R—32 inches; hard limestone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

113—Rock outcrop-Skos-Seis families complex, 30 to 60 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,500 to 6,000 feet (1,372 to 1,829 meters)

Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)

Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)

Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)

Frost-free period: 145 to 160 days

Map Unit Composition

Rock outcrop: 40 percent

Skos family and similar soils: 35 percent

Seis family and similar soils: 20 percent

Minor components: 5 percent

- Soils that have accumulation of calcium carbonate in the profile
- Soils that are deep or very deep to bedrock

- Soils that have gypsum present in the profile
- Skree slopes which are devoid of vegetation
- Soils that have an accumulation of clay in the profile

Properties and Qualities

Rock outcrop

Very steep to vertical canyon walls and escarpments of limestone of the Redwall and Muav Formations

Skos family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, calcareous, mesic Lithic Ustic Torriorthents

Geomorphic position: pockets and ledges of steep canyon walls

Parent material: colluvium derived from limestone and sandstone

Slope: 30 to 60 percent

Surface fragments: about 20 percent stones, about 50 percent coarse gravel, about 10 percent cobbles

Depth to restrictive feature: 10 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 0.8

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Sedimentary Cliffs 10-14" p.z.

Ecosystem site number: 035XC302AZ

Present native vegetation: other evergreen trees, pointleaf manzanita, turbinella oak, Wyoming big sagebrush, skunkbush sumac, spiny greasewood

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Tonto Platform; 1,343 feet southwest of Bright Angel Trail; 36 degrees, 3 minutes, 57 seconds north latitude; 112 degrees, 8 minutes, 3 seconds west longitude.

A—0 to 2 inches; brown (7.5YR 5/4) extremely stony loam; brown (7.5YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine tubular pores; 25 percent gravel, 20 percent cobble, and 30 percent stone; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bw—2 to 7 inches; light brown (7.5YR 6/4) extremely gravelly loam; brown (7.5YR 5/4) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine and medium roots; common very fine and fine tubular pores; 40 percent gravel, 20 percent cobble, and 10 percent stone; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

C—7 to 17 inches; light brown (7.5YR 6/4) extremely cobbly loam; brown (7.5YR 5/4) moist; massive; soft, very friable, slightly sticky and slightly plastic; common fine and medium roots; common fine and medium tubular pores; calcium carbonate is disseminated throughout; 15 percent gravel, 30 percent cobble, and 10 percent stone; violently effervescent; moderately alkaline (pH 8.4); abrupt wavy boundary.

R—17 inches; fractured limestone bedrock.

Range in Characteristics

Depth to bedrock: 10 to 20 inches

Clay content: 8 to 12 percent in the particle size control section

Rock fragments: 35 to 75 percent in the particle size control section

A horizon

Hue: 7.5YR, 10YR

Value: 5 through 7, dry or moist

Chroma: 2 through 4, dry or moist

Calcium carbonate equivalent: 5 to 20 percent

C horizon

Hue: 7.5YR, 10YR

Value: 5 through 7, dry or moist

Chroma: 2 through 4, dry or moist

Rock fragments: 35 to 60 percent

Calcium carbonate equivalent: 5 to 20 percent

Seis family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Ustic Haplocalcids

Geomorphic position: pockets and ledges on steep canyon walls

Parent material: residuum weathered from argillaceous limestone

Slope: 30 to 60 percent

Surface fragments: about 15 percent stones, about 15 percent cobbles, about 40 percent coarse gravel

Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 1.5

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: C

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Sedimentary Cliffs 10-14" p.z.

Ecosystem site number: 035XC302AZ

Present native vegetation: other evergreen trees, pointleaf manzanita, turbinella oak, Wyoming big sagebrush, skunkbush sumac, spiny greasewood

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Tonto Platform; 1,253 feet southwest of Bright Angel Trail; 36 degrees, 3 minutes, 59 seconds north latitude; 112 degrees, 8 minutes, 5 seconds west longitude.

A—0 to 4 inches; brown (7.5YR 5/4) extremely stony fine sandy loam; brown (7.5YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and common medium roots; many very fine and fine tubular pores; 25 percent gravel, 10 percent cobble, and 30 percent stone; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bk1—4 to 13 inches; pink (5YR 7/4) very gravelly fine sandy loam; light reddish brown (5YR 6/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and medium and few coarse roots; few fine and medium tubular pores; common fine soft masses of calcium carbonate; common moderately thick calcium carbonate coats and pendants on the undersides and sides of rock fragments; 40 percent gravel, 5 percent cobble; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bk2—13 to 32 inches; light reddish brown (5YR 6/4) very gravelly fine sandy loam; reddish brown (5YR 5/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and medium and few coarse roots; few fine and medium tubular pores; common fine soft masses of calcium carbonate; common moderately thick calcium

carbonate coats and pendants on the undersides and sides of rock fragments; 40 percent gravel, 5 percent cobble; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

R—32 inches; hard limestone bedrock.

Range in Characteristics

Rock fragments: 40 to 70 percent in the particle size control

Calcium carbonate: 15 to 40 percent in the Bw or Bk horizons

Depth to bedrock: 20 to 40 inches

A horizon

Hue: 7.5YR, 10YR

Value: 5 through 7 dry, 4 through 6 moist

Chroma: 2 through 44, dry or moist

Other features: In some pedons, the surface 2-inch layer is crusted and vesicular.

Bk horizons

Hue: 5YR, 7.5YR, 10YR

Value: 4 through 7 dry, 3 through 5 moist

Chroma: 2 through 44, dry or moist

114—Rock outcrop-Torriorthents complex, Kaibab Formation, 15 to 85 percent slopes

Map Unit Setting

Landform: hill

Elevation: 1,200 to 1,600 feet (366 to 487 meters)

Mean annual precipitation: 6 to 9 inches (152 to 229 millimeters)

Mean annual air temperature: 64 to 70 degrees F (18 to 21 degrees C)

Mean annual soil temperature: 66 to 72 degrees F (20 to 23 degrees C)

Frost-free period: 230 to 280 days

Map Unit Composition

Rock outcrop: 70 percent

Torriorthents and similar soils: 30 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor

components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Rock outcrop

Ridges, cliffs and scarps composed of sandy limestone and limy sandstone of the Kaibab Formation

Torriorthents soils

Taxonomic classification: Torriorthents

Geomorphic position: side slopes of ridges

Parent material: colluvium derived from limestone and sandstone and/or residuum weathered from limestone and sandstone

Slope: 15 to 85 percent

Depth to restrictive feature: 4 to 30 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 30

Land Resource Unit: 30-2

Ecological site name: Limestone Hills 6-9" p.z.

Ecosystem site number: 030XB210AZ

Present native vegetation: Nevada Mormon tea, big galleta, bush muhly, Opuntia, rayless brittlebush, white ratany, agave

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 1,916 feet southwest of Never Shines Cove; 36 degrees, 10 minutes, 45 seconds north latitude; 113 degrees, 59 minutes, 8 seconds west longitude.

A—0 to 2 inches; yellowish brown (10YR 5/4) extremely cobbly loam, dark yellowish brown (10YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; common very fine through medium tubular pores; 45 percent gravel, 20 percent cobble; 5 percent stone; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

C1—2 to 10 inches; light yellowish brown (10YR 6/4) very cobbly loam, dark yellowish brown (10YR 4/4) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine and common medium and coarse roots; common fine and medium and few coarse tubular pores; 25 percent gravel, 15 percent cobble; violently effervescent; moderately alkaline (pH 8.2); clear irregular boundary.

C2—10 to 19 inches; light yellowish brown (10YR 6/4) extremely gravelly loam, yellowish brown (10YR 5/4) moist; weak fine subangular blocky structure; soft, very friable, moderately sticky and moderately plastic; common very fine through coarse roots; common fine through coarse tubular pores; 55 percent gravel, 15 percent cobble; violently effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

2R—19 inches; limestone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

115—Rock outcrop-Torriorthents-Lithic Torriorthents complex, Supai Group and Redwall Formation, 2 to 60 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 2,500 to 4,500 feet (762 to 1,371 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 68 degrees F (14 to 20 degrees C)

Mean annual soil temperature: 59 to 70 degrees F (16 to 22 degrees C)

Frost-free period: 200 to 320 days

Map Unit Composition

Rock outcrop: 50 percent

Torriorthents and similar soils: 30 percent

Lithic Torriorthents and similar soils: 20 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Rock outcrop

Vertical cliffs of the Redwall Formation overlain by

ledges and cliffs of the lower members of the Supai Group

Torriorthents soils

Taxonomic classification: Torriorthents

Geomorphic position: colluvial slopes

Parent material: colluvium derived from limestone and sandstone

Slope: 2 to 30 percent

Depth to restrictive feature: 21 to 60 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limestone Hills 6-10" p.z.

Ecosystem site number: 035XE505AZ

Present native vegetation: blackbrush, black grama, slim tridens, ephedra, Stansbury cliffrose, Utah agave

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Esplanade; 346 feet southwest of Georges Spring; 36 degrees, 10 minutes, 2 seconds north latitude; 113 degrees, 19 minutes, 50 seconds west longitude.

A—0 to 3 inches; red (2.5YR 5/6) extremely stony sandy loam; dark reddish brown (2.5YR 3/4) moist; moderate medium granular structure; soft, very friable, nonsticky and nonplastic; common very fine through medium and few coarse roots; many very fine through medium tubular pores; 30 percent gravel, 20 percent cobble, and 20 percent stone; strongly effervescent; moderately alkaline (pH 8.0); clear wavy boundary.

C—3 to 45 inches; red (2.5YR 5/6) extremely stony sandy loam; reddish brown (2.5YR 4/4) moist; moderate very fine and fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine through medium and few coarse roots; many very fine and fine and few medium tubular pores; 20 percent gravel, 20 percent cobble, and 25 percent stone; violently effervescent, moderately alkaline (pH 8.2); abrupt irregular boundary.

R—45 inches; highly fractured, slightly weathered Supai sandstone bedrock with more than 4 inches between cracks; many very fine and fine roots occur in fractures.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical

properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Lithic Torriorthents soils

Taxonomic classification: Lithic Torriorthents

Geomorphic position: ledges and pockets in canyon walls

Parent material: colluvium derived from limestone and sandstone

Slope: 20 to 60 percent

Depth to restrictive feature: 4 to 15 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Sedimentary Cliffs 6-10" p.z.

Ecosystem site number: 035XE516AZ

Present native vegetation: Torrey Mormon tea, shadscale saltbush, beavertail pricklypear, blue threeawn, bush muhly

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Esplanade; 2.25 miles north of Whitmore Rapids; 36 degrees, 10 minutes, 37 seconds north latitude; 113 degrees, 12 minutes, 38 seconds west longitude.

A—0 to 1 inch; light yellowish brown (10YR 6/4) very gravelly loam; dark yellowish brown (10YR 4/4) moist; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; few fine tubular pores; 35 percent gravel, 5 percent cobble, 5 percent stone; violently effervescent, moderately alkaline (pH 8.0); abrupt smooth boundary.

Bw1—1 to 3 inches; light yellowish brown (10YR 6/4) very gravelly loam; dark yellowish brown (10YR 4/4) moist; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; few fine tubular pores; 25 percent gravel, 5 percent cobble, 5 percent stone; violently effervescent, moderately alkaline (pH 8.2); abrupt smooth boundary.

Bw2—3 to 7 inches; light yellowish brown (10YR 6/4) very gravelly loam; dark yellowish brown (10YR 4/4) moist; moderate fine subangular blocky structure;

slightly hard, very friable, slightly sticky and slightly plastic; few very fine roots; few fine tubular pores; 25 percent gravel, 15 percent cobble; violently effervescent; moderately alkaline (pH 8.0); abrupt irregular boundary.

R—7 inches; Redwall Limestone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

116—Rock outcrop-Typic Torriorthents complex, Hermit Formation, 15 to 60 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,200 to 6,000 feet (976 to 1,829 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 55 to 57 degrees F (13 to 14 degrees C)

Mean annual soil temperature: 57 to 59 degrees F (15 to 16 degrees C)

Frost-free period: 160 to 175 days

Map Unit Composition

Rock outcrop: 60 percent

Typic Torriorthents and similar soils: 40 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Rock outcrop

Very steep pediments of the Hermit Formation on canyon side walls

Typic Torriorthents soils

Taxonomic classification: Typic Torriorthents

Geomorphic position: colluvial slopes on plateau escarpments and canyon sidewalls

Parent material: colluvium derived from limestone and sandstone

Slope: 15 to 60 percent

Depth to restrictive feature: 21 to 60 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-2

Ecological site name: Breaks 6-10" p.z.

Ecosystem site number: 035XB201AZ

Present native vegetation: Torrey Mormon tea, shadscale saltbush, Sporobolus, beavertail pricklypear, bush muhly

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 1.38 miles northeast of Soap Creek Rapids; 36 degrees, 45 minutes, 3 seconds north latitude; 111 degrees, 40 minutes, 25 seconds west longitude.

C1—0 to 8 inches; light brown (7.5YR 6/4) extremely stony fine sandy loam; brown (7.5YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine roots, many very fine irregular pores; 20 percent gravel, 10 percent cobble, and 60 percent stone; strongly effervescent; moderately alkaline (pH 8.4); clear irregular boundary.

C2—8 to 20 inches; reddish yellow (5YR 6/6) very stony coarse sandy loam; yellowish red (5YR 5/6) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few fine roots; common fine irregular pores; common fine soft masses and plates of gypsum; 5 percent gravel, 20 percent cobble, and 20 percent stone; noneffervescent; moderately alkaline (pH 8.2); clear irregular boundary.

C3—20 to 40 inches; yellowish red (5YR 5/6) very gravelly sandy clay loam; yellowish red (5YR 4/6) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few fine roots; common fine irregular pores; common fine soft masses and plates of gypsum; 20 percent gravel, 10 percent cobble, and 5 percent stone; noneffervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

2R—40 inches; Hermit shale bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined.

Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

117—Rock outcrop-Typic Torriorthents complex, Tonto Group and Redwall Formation, 30 to 60 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 2,500 to 3,500 feet (762 to 1,067 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 200 to 240 days

Map Unit Composition

Rock outcrop: 60 percent

Typic Torriorthents and similar soils: 40 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Rock outcrop

Tall, vertical cliffs and escarpments

Typic Torriorthents soils

Taxonomic classification: Typic Torriorthents

Geomorphic position: colluvial slopes on ledges and canyon sidewalls of plateau escarpments

Parent material: colluvium derived from limestone, sandstone, and shale and/or residuum weathered from limestone

Slope: 15 to 60 percent

Depth to restrictive feature: 21 to 50 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Sedimentary Cliffs 6-10" p.z.

Ecosystem site number: 035XE516AZ

Present native vegetation: Torrey Mormon tea, shadscale saltbush, beavertail pricklypear, blue threeawn, bush muhly

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 2,551 feet southwest of Tatahatso Wash; 36 degrees, 26 minutes, 5 seconds north latitude; 111 degrees, 51 minutes, 13 seconds west longitude.

A—0 to 10 inches; strong brown (7.5YR 5/6) extremely stony loamy very fine sand; brown (7.5YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine roots; common very fine tubular pores; 15 percent gravel, 20 percent cobble, and 30 percent stone; slightly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

C1—10 to 20 inches; strong brown (7.5YR 5/6) extremely stony loamy very fine sand; brown (7.5YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; few very fine tubular pores; 15 percent gravel, 20 percent cobble, and 30 percent stone; slightly effervescent; strongly alkaline (pH 8.6); clear smooth boundary.

C2—20 to 30 inches; strong brown (7.5YR 5/6) extremely stony loamy very fine sand; brown (7.5YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; few very fine tubular pores; 15 percent gravel, 20 percent cobble, and 30 percent stone; slightly effervescent; strongly alkaline (pH 8.6); abrupt irregular boundary.

R—30 inches; Redwall limestone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

118—Rockyroad very cobbly silty clay loam, 2 to 10 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,900 to 6,300 feet (1,798 to 1,920 meters)
Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)
Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)
Mean annual soil temperature: 50 to 54 degrees F (11 to 13 degrees C)
Frost-free period: 135 to 150 days

Map Unit Composition

Rockyroad and similar soils: 85 percent
 Minor components: 15 percent

- Rubbleland
- Rock outcrop
- Soils that have less than 15 percent surface coarse fragments
- Rockyroad similar soils that are more than 20 inches deep
- Soils that have eroded surfaces subject to very brief flooding

Properties and Qualities

Rockyroad soils

Taxonomic classification: Clayey, smectitic, mesic Lithic Haplusterts
Geomorphic position: summits and side slopes of basalt flows
Parent material: residuum weathered from basalt
Slope: 2 to 10 percent
Surface fragments: about 5 percent boulders, about 10 percent stones, about 25 percent coarse gravel, about 20 percent cobbles
Depth to restrictive feature: 14 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Permeability: about 0.01 in/hr (very slow)
Available water capacity total inches: 2.0
Shrink-swell potential: about 12.0 LEP (very high)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: very high
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-6
Ecological site name: Basalt Upland (JUOS) 13-17" p.z.
Ecosystem site number: 035XF620AZ
Present native vegetation: Utah juniper, muttongrass, Colorado pinyon, Stansbury cliffrose, bottlebrush squirreltail, turbinella oak
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Shivwits Plateau; 1,000 feet southwest of Pine Valley; 36 degrees, 6 minutes, 14 seconds north latitude; 113 degrees, 27 minutes, 4 seconds west longitude.

A—0 to 2 inches; variegated strong brown (7.5YR 4/6) and dark brown (7.5YR 3/3) very cobbly silty clay loam; strong brown (7.5YR 3/4) and very dark brown (7.5YR 2.5/2) moist; strong fine granular structure; soft, very friable, moderately sticky and moderately plastic; many very fine irregular pores; 15 percent gravel, 10 percent cobble, 5 percent stone, and 5 percent boulder; noneffervescent, neutral (pH 7.2); abrupt wavy boundary.

Bt—2 to 4 inches; dark brown (7.5YR 3/3) clay; very dark brown (7.5YR 2.5/3) moist; strong medium subangular blocky structure parting to strong very fine angular blocky; hard, friable, very sticky and very plastic; common very fine and fine roots; many very fine irregular and few fine tubular pores; less than 5 percent boulders and stone; many distinct clay films on faces of peds and lining pores; noneffervescent; neutral (pH 7.0); abrupt wavy boundary.

Btss1—4 to 9 inches; reddish brown (5YR 4/4) clay; dark reddish brown (5YR 3/3) moist; strong medium prismatic structure parting to strong medium angular blocky; hard, firm, very sticky and very plastic; common fine and few medium roots; few fine tubular pores; few distinct clay films on faces of peds and lining pores; many intersecting slickensides and pressure faces; 2- to 5-millimeter wide vertical cracks which are about 4 inches apart; noneffervescent; neutral (pH 6.8); abrupt wavy boundary.

Btss2—9 to 17 inches; brown (7.5YR 4/4) clay; dark brown (7.5YR 3/4) moist; strong medium prismatic structure parting to strong medium angular blocky; hard, firm, very sticky and very plastic; common fine and medium roots; few fine tubular pores; 10 percent gravel; very few faint clay films on faces of peds and lining pores; many intersecting slickensides and pressure faces; 2- to 5-millimeter wide vertical cracks which are about 4 inches apart; noneffervescent; neutral (pH 6.8); abrupt wavy boundary.

Cr—17 to 19 inches; discontinuous weathered basalt.
 R—19 inches; basalt bedrock.

Range in Characteristics

Depth to bedrock: 14 to 20 inches
 Rock fragments: average less than 15 percent in the particle size control section

Clay content: averages 40 to 60 percent in the particle size control section

Reaction: slightly acid to neutral

A horizon

Hue: 5YR, 7.5YR

Value: 3 or 4 dry, 2.5 or 3 moist

Chroma: 2 through 6, dry or moist

Bt horizons

Hue: 5YR, 7.5YR

Value: 3 or 4 dry, 2.5 or 3 moist

Chroma: 3 or 4, dry or moist

Btss horizons

Hue: 5YR, 7.5YR

Value: 3 or 4, dry or moist

Chroma: 2 through 4, dry or moist

119—Skos family-Rock outcrop complex, 15 to 55 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,500 to 7,000 feet (1,372 to 2,134 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)

Mean annual soil temperature: 50 to 54 degrees F (11 to 13 degrees C)

Frost-free period: 135 to 150 days

Map Unit Composition

Skos family and similar soils: 55 percent

Rock outcrop: 30 percent

Minor components: 15 percent

- Soils that have accumulation of calcium carbonate in the profile
- Soils that are deep or very deep to bedrock
- Soils that have gypsum present in the profile
- Skree slopes which are devoid of vegetation
- Soils that have an accumulation of clay in the profile

Properties and Qualities

Skos family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, calcareous, mesic Lithic Ustic Torriorthents

Geomorphic position: pockets and ledges of plateau escarpments

Parent material: colluvium derived from calcareous sandstone

Slope: 15 to 55 percent

Surface fragments: about 30 percent coarse gravel, about 5 percent stones, about 30 percent cobbles

Depth to restrictive feature: 4 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 0.9

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Sedimentary Cliffs 13-17" p.z.

Ecosystem site number: 035XF601AZ

Present native vegetation: littleleaf mountain-mahogany, turbinella oak, other evergreen trees, pointleaf manzanita, desert needlegrass

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 3,731 feet south of Hundred and Ninetythree Mile Creek; 36 degrees, 4 minutes, 47 seconds north latitude; 113 degrees, 13 minutes, 46 seconds west longitude.

A—0 to 2 inches; reddish brown (5YR 5/4) extremely cobbly loam; reddish brown (5YR 4/3) moist; moderate fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine through coarse roots; many fine tubular pores; 40 percent gravel, 35 percent cobble, and 5 percent stone; strongly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bw—2 to 10 inches; yellowish red (5YR 5/6) very cobbly loam; reddish brown (5YR 5/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine through coarse roots; common fine tubular pores; 15 percent gravel, 25 percent cobble, and 5 percent stone; strongly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

C—10 to 19 inches; yellowish red (5YR 5/6) extremely cobbly loam; reddish brown (5YR 5/4) moist; massive; soft, very friable, nonsticky and nonplastic; common medium and coarse roots; few fine tubular pores; 40 percent gravel, 25 percent cobble, and 5 percent stone;

violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

R—19 inches; fractured sandstone bedrock with accumulations of calcium carbonate inside the fractures.

Range in Characteristics

Depth to bedrock: 4 to 20 inches
Particle size control section (weighted average):
Clay content: 8 to 12 percent
Rock fragments: 35 to 75 percent

A horizon

Hue: 5YR 7.5YR, 10YR
Value: 5 through 7, dry or moist
Chroma: 2 through 4, dry or moist
Calcium carbonate equivalent: 5 to 20 percent

C horizon

Hue: 5YR, 7.5YR, 10YR
Value: 5 through 7, dry or moist
Chroma: 2 through 4, dry or moist
Rock fragments: 35 to 60 percent
Calcium carbonate equivalent: 5 to 20 percent

Rock outcrop

Steep ledges and cliffs composed of sandstone and siltstone of the Supai Group

120—Skos family-Sandia-Rock outcrop complex, 15 to 55 percent slopes

Map Unit Setting

Landform: plateau
Elevation: 5,000 to 7,500 feet (1,524 to 2,286 meters)
Mean annual precipitation: 13 to 33 inches (330 to 838 millimeters)
Mean annual air temperature: 36 to 48 degrees F (2 to 9 degrees C)
Mean annual soil temperature: 38 to 50 degrees F (4 to 11 degrees C)
Frost-free period: 70 to 160 days

Map Unit Composition

Skos family and similar soils: 40 percent
Sandia and similar soils: 30 percent
Rock outcrop: 15 percent
Minor components: 15 percent

- Soils that have accumulation of calcium carbonate in the profile
- Soils that are deep or very deep to bedrock

- Soils that have gypsum present in the profile
- Skree slopes which are devoid of vegetation
- Soils that have an accumulation of clay in the profile

Properties and Qualities

Skos family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, calcareous, mesic Lithic Ustic Torriorthents
Geomorphic position: south-facing pockets and ledges on plateau escarpments
Parent material: colluvium and/or residuum weathered from limestone
Slope: 15 to 55 percent
Surface fragments: about 15 percent coarse gravel, about 30 percent cobbles, about 5 percent stones
Depth to restrictive feature: 4 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Permeability: about 4.00 in/hr (moderately rapid)
Available water capacity total inches: 0.5
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: very high
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-6
Ecological site name: Sedimentary Cliffs 13-17" p.z.
Ecosystem site number: 035XF601AZ
Present native vegetation: littleleaf mountain-mahogany, turbinella oak, other evergreen trees, pointleaf manzanita, desert needlegrass
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: Below the Coconino Plateau; 914 feet south of Lipan Point; 36 degrees, 1 minute, 50 seconds north latitude; 111 degrees, 51 minutes, 8 seconds west longitude.

A—0 to 1 inch; pale brown (10YR 6/3) extremely gravelly very fine sandy loam, brown (10YR 5/3) moist; single grain; loose, nonsticky and nonplastic; many very fine irregular pores; 85 percent limestone gravel; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

C—1 to 6 inches; pale brown (10YR 6/3) extremely gravelly very fine sandy loam, brown (10YR 5/3) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine roots;

many very fine irregular pores; 75 percent limestone gravel; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

R—6 inches; limestone bedrock.

Range in Characteristics

Depth to bedrock: 4 to 20 inches
Particle size control section (weighted average):
Clay content: 8 to 12 percent
Rock fragments: 35 to 60 percent

A horizon

Hue: 5YR, 7.5YR, 10YR
Value: 5 through 7, dry or moist
Chroma: 2 through 4, dry or moist
Calcium carbonate equivalent: 5 to 20 percent

C horizon

Hue: 5YR, 7.5YR, 10YR
Value: 5 through 7, dry or moist
Chroma: 2 through 4, dry or moist
Rock fragments: 35 to 60 percent
Calcium carbonate equivalent: 5 to 20 percent

Sandia soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, frigid Udic Haplustolls

Geomorphic position: north-facing pockets and ledges of plateau escarpments

Parent material: colluvium derived from limestone and sandstone

Slope: 15 to 55 percent

Surface fragments: about 30 percent cobbles, about 5 percent stones, about 15 percent coarse gravel

Depth to restrictive feature: 25 to 60 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 3.3

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-9

Ecological site name: Sedimentary Cliffs 25-33" p.z.

Ecosystem site number: 035XI901AZ

Present native vegetation: Douglas-fir, Gambel oak, New Mexico locust, other evergreen trees, white fir, Symphoricarpus, Utah serviceberry

Land capability (nonirrigated): 5c

Taxonomic Unit Description

Type Location: Below the Coconino Plateau; 4,450 feet south of Yaki Point; 36 degrees, 2 minutes, 47 seconds north latitude; 112 degrees, 4 minutes, 57 seconds west longitude.

A—0 to 4 inches; very dark grayish brown (10YR 3/2) very cobbly fine sandy loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and common medium and coarse roots; common fine and medium interstitial and tubular pores; 25 percent gravel, 30 percent limestone cobble; slightly effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bw1—4 to 20 inches; very dark grayish brown (10YR 3/2) extremely gravelly fine sandy loam, very dark brown (10YR 2/2) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine through coarse roots; common fine and medium interstitial and tubular pores; 50 percent gravel, 15 percent cobble; slightly effervescent; moderately alkaline (pH 8.2); clear wavy boundary.

Bw2—20 to 36 inches; very dark grayish brown (10YR 3/2) extremely cobbly fine sandy loam, very dark brown (10YR 2/2) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine through coarse roots; common fine and medium interstitial and tubular pores; 50 percent gravel, 35 percent cobble; slightly effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

R—36 inches; fractured limestone bedrock.

Range in Characteristics

This is a taxadjunct to the series. The series is Typic Ustic and this is Udic Ustic.

Depth to bedrock: 25 to 60 inches

Rock fragments: 50 to 80 percent

A horizon

Hue: 10YR, 7.5YR

Value: 4 or 5 dry, 2 or 3 moist

Chroma: 1 or 2, dry or moist

Bw horizon

Hue: 10YR, 7.5YR

Value: 5 or 6 dry, 4 or 5 moist

Chroma: 3 or 4

Rock outcrop

Ledges and outcrops of sandy limestone and limy sandstone of the Kaibab Formation

121—Tassi gravelly loamy very fine sand, 0 to 3 percent slopes

Map Unit Setting*Landform:* plateau*Elevation:* 5,840 to 6,060 feet (1,780 to 1,847 meters)*Mean annual precipitation:* 10 to 14 inches (254 to 356 millimeters)*Mean annual air temperature:* 52 to 55 degrees F (11 to 13 degrees C)*Mean annual soil temperature:* 54 to 57 degrees F (13 to 15 degrees C)*Frost-free period:* 150 to 175 days**Map Unit Composition**

Tassi and similar soils: 98 percent

Minor components: 2 percent

- Soils greater than 10 inches deep with an argillic and/or calcic horizon

Properties and Qualities**Tassi soils***Taxonomic classification:* Loamy-skeletal, mixed, active, mesic, shallow Ustic Petrocalcids*Geomorphic position:* summits of plateaus*Parent material:* sandy alluvium and/or sandy colluvium derived from calcareous sandstone*Slope:* 0 to 3 percent*Surface fragments:* about 20 percent medium subangular gravel*Depth to restrictive feature:* 14 to 20 inches to petrocalcic*Drainage class:* Well drained*Permeability:* about 4.00 in/hr (moderately rapid)*Available water capacity total inches:* 1.7*Shrink-swell potential:* about 1.5 LEP (low)*Flooding hazard:* None*Seasonal water table minimum depth:* greater than 6 feet*Runoff class:* very low*Hydrologic group:* D*Major Land Resource Area:* 35*Land Resource Unit:* 35-3*Ecological site name:* Shallow Loamy 10-14" p.z.*Ecosystem site number:* 035XC319AZ*Present native vegetation:* Wyoming big sagebrush, blue grama, galleta, ephedra, bottlebrush squirreltail*Land capability (nonirrigated):* 6c**Taxonomic Unit Description**

Type Location: On the Marble Platform; 36 degrees, 17 minutes, 10 seconds north latitude; 111 degrees, 48 minutes, 20 seconds west longitude.

AB—0 to 2 inches; strong brown (7.5YR 4/6) gravelly loamy very fine sand, dark brown (7.5YR 3/4) moist; weak fine granular structure; loose, nonsticky and nonplastic; common very fine roots; no pores; strongly effervescent; 20 percent gravel; moderately alkaline (pH 8.0); abrupt smooth boundary.

Bk1—2 to 10 inches; brown (7.5YR 5/4) gravelly very fine sandy loam, strong brown (7.5YR 4/6) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine and few fine roots; common very fine irregular pores; violently effervescent; 15 percent gravel; moderately alkaline (pH 8.2); clear smooth boundary.

Bk2—10 to 19 inches; brown (7.5YR 5/4) extremely flaggy very fine sandy loam, strong brown (7.5YR 4/6) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and few fine roots; many very fine irregular and dendritic tubular pores; violently effervescent; 15 percent gravel-size, 30 percent cobble-size, 15 percent flagstone (stone-size) petrocalcic fragments; moderately alkaline (pH 8.2); clear smooth boundary.

Bkm—19 inches; pinkish white (7.5YR 8/2), indurated petrocalcic, pinkish gray (7.5YR 7/2) moist; very thick platy structure.

Range in Characteristics

This soil is a taxadjunct to the Tassi series. The Tassi series classifies as a Loamy, mixed, mesic, shallow Ustic Petrocalcids. This soil has more than 35 percent coarse fragments in the particle size control section and the cation-exchange activity class is active.

122—Topocoba family, 2 to 8 percent slopes

Map Unit Setting*Landform:* plateau*Elevation:* 5,500 to 7,000 feet (1,676 to 2,134 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)
Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)
Mean annual soil temperature: 50 to 54 degrees F (11 to 13 degrees C)
Frost-free period: 135 to 150 days

Map Unit Composition

- Topocoba family and similar soils: 90 percent
Minor components: 10 percent
- Soils that are deep to bedrock
 - Soils that are very shallow to bedrock
 - Soils that have no accumulation of clay in the profile
 - Soils that have no accumulation of calcium carbonate in the profile
 - Soils that have less than 35 percent by volume rock fragments in the profile
 - Soils in drainageways that are subject to occasional flooding
 - Rock outcrop

Properties and Qualities

Topocoba family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic, shallow Petrocalcic Paleustalfs
Geomorphic position: summits and sideslopes of low hills and ridges of basalt lava flows
Parent material: residuum weathered from basalt
Slope: 2 to 8 percent
Surface fragments: about 40 percent gravel, about 5 percent cobbles, about 2 percent stones
Depth to restrictive feature: 15 to 30 inches to bedrock (lithic); 10 to 20 inches to petrocalcic
Drainage class: Well drained
Permeability: about 0.40 in/hr (moderately slow)
Available water capacity total inches: 1.8
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: High
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-6
Ecological site name: Basalt Upland (JUOS) 13-17" p.z.
Ecosystem site number: 035XF620AZ
Present native vegetation: Utah juniper, muttongrass, Colorado pinyon, Stansbury cliffrose, bottlebrush squirreltail, turbinella oak
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On Tuckup Point; 1.36 miles south of Hancock Knoll; 36 degrees, 23 minutes, 53 seconds north latitude; 112 degrees, 57 minutes, 38 seconds west longitude.

A—0 to 4 inches; reddish brown (5YR 4/4) very gravelly loam; dark reddish brown (5YR 3/3) moist; weak medium platy structure parting to moderate medium and fine subangular blocky; slightly hard, very friable, nonsticky and slightly plastic; many very fine and few fine and medium roots; common very fine

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Clay content: 15 to 35 percent in the control section
 Depth to petrocalcic horizon: 10 to 20 inches
 Depth to bedrock: 15 to 30 inches
 Calcium carbonate equivalent: Less than 30 percent above the hardpan
 Organic matter: averages more than 1 percent in the surface

A horizon

Hue: 5YR, 7.5YR
 Value: 4 or 5 dry, 3 or 4 moist
 Chroma: 3 or 4, dry or moist

Btk horizon

Hue: 5YR, 7.5YR
 Value: 4 or 5 dry, 3 or 4 moist
 Chroma: 3 through 6, dry or moist

123—Topocoba-Wodomont association, 2 to 15 percent slopes

Map Unit Setting

Landform: plateau
Elevation: 5,800 to 6,200 feet (1768 to 1,890 meters)
Mean annual precipitation: 14 to 16 inches (356 to 406 millimeters)
Mean annual air temperature: 52 to 55 degrees F (11 to 12 degrees C)
Mean annual soil temperature: 54 to 57 degrees F (12 to 14 degrees C)
Frost-free period: 130 to 160 days

Map Unit Composition

Topocoba and similar soils: 45 percent
 Wodomont and similar soils: 40 percent
 Minor components: 15 percent

- Soils that are more than 20 inches deep
- Rock outcrop
- Soils that have a large amount of calcium carbonate in the profile

Properties and Qualities

Topocoba soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic, shallow Petrocalcic Paleustalfs
Geomorphic position: summits
Parent material: alluvium derived from limestone and sandstone
Slope: 2 to 8 percent

Depth to restrictive feature: 15 to 40 inches to bedrock (lithic); 10 to 20 inches to petrocalcic
Drainage class: Well drained
Permeability: about 0.40 in/hr (moderately slow)
Available water capacity total inches: 1.1
Shrink-swell potential: about 4.5 LEP (moderate)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: Low
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-6
Ecological site name: Shallow Loamy 13-17" p.z.
Ecosystem site number: 035XF608AZ
Present native vegetation: Wyoming big sagebrush, blue grama, muttongrass, green Mormon tea, other evergreen trees
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: about 1,200 feet south and 1,600 feet west of the northeast corner of section 8, township 32 north, range 2 west; 36 degrees, 10 minutes, 38.2 seconds north latitude; 112 degrees, 12 minutes, 12.2 seconds west longitude.

A—0 to 1 inch; brown (7.5YR 5/4) gravelly very fine sandy loam; dark brown (7.5YR 4/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine roots; common very fine irregular pores; 20 percent gravel; very slightly effervescent; neutral (pH 8.8); abrupt smooth boundary.

Bt—1 to 6 inches; reddish brown (5YR 4/4) gravelly sandy clay loam; dark reddish brown (5YR 3/4) moist; weak fine subangular blocky structure, slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; few faint clay films lining pores; 15 percent gravel, 5 percent cobble; slightly effervescent; neutral (pH 7.3); abrupt smooth boundary.

Bk1—6 to 12 inches; reddish brown (5YR 4/4) extremely cobbly sandy clay loam; dark reddish brown (5YR 3/4) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; few very fine tubular pores; 30 percent gravel, 30 percent cobble, predominantly hardpan fragments; strongly effervescent; slightly alkaline (pH 7.6); abrupt wavy boundary.

Bk2—12 to 17 inches; reddish brown (5YR 5/4)

extremely cobbly sandy clay loam; reddish brown (5YR 4/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; 10 percent gravel, 60 percent cobble, 10 percent stone, predominantly hardpan fragments; violently effervescent; moderately alkaline (pH 8.0); abrupt wavy boundary.

2Bkm—17 to 22 inches; calcium carbonate cemented hardpan.

3R—22 inches; limestone bedrock.

Range in Characteristics

Depth to a hardpan: 10 to 20 inches

Depth to bedrock: 15 to 30 inches

Content of rock fragments in the control section: 35 to 70 percent

Bt horizon

Texture—gravelly sandy clay loam, loam, clay loam

Bk horizon

Texture—extremely cobbly sandy clay loam, loam, clay loam

Calcium carbonate—10 to 30 percent in the subsoil

Wodomont soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Calciustepts

Geomorphic position: summits

Parent material: alluvium derived from limestone and sandstone

Slope: 5 to 15 percent

Depth to restrictive feature: 6 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 1.3

Shrink-swell potential: about 1.5 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Medium

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Limestone Upland (JUOS, PIED) 13-17" p.z.

Ecosystem site number: 035XF619AZ

Present native vegetation: Artemisia, Utah juniper, Colorado pinyon, Stansbury cliffrose, green Mormon tea

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: about 2,000 feet north and 500 feet west of the southeast corner of section 9, township 32 north, range 2 west; 36 degrees, 10 minutes, 17.4 seconds north latitude; 112 degrees, 11 minutes, 20.8 seconds west longitude.

A—0 to 3 inches; brown (7.5YR 5/3) extremely cobbly loam; dark brown (7.5YR 4/3) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine roots; common very fine irregular pores; 50 percent gravel, 30 percent cobble; strongly effervescent; slightly alkaline (pH 7.6); abrupt wavy boundary.

Bk1—3 to 12 inches; brown (7.5YR 5/4) extremely cobbly loam; dark brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and moderately plastic; many very fine roots; common very fine tubular pores; common thin calcium carbonate coatings and pendants on the undersides of rock fragments; 20 percent gravel, 50 percent cobble; violently effervescent; slightly alkaline (pH 7.5); abrupt wavy boundary.

Bk2—12 to 15 inches; light brown (7.5YR 6/4) very gravelly loam; dark brown (7.5YR 4/4) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and moderately plastic; few very fine roots; few very fine tubular pores; common medium soft calcium carbonate masses and common thin coatings and pendants on rock fragments; 35 percent gravel, 15 percent cobble; violently effervescent; slightly alkaline (pH 7.8); abrupt wavy boundary.

R—15 inches; limestone bedrock.

Range in Characteristics

Clay content (control section): 15 to 25 percent

Rock fragment content (control section): 35 to 60 percent

Calcium carbonate equivalent: averages 20 to 40 percent

A horizon

Hue: 5YR, 7.5YR

Value: 3 through 5 moist

Chroma: 3 or 4, dry or moist

Bk horizon

Hue: 5YR, 7.5YR

Value: 4 or 5 dry, 3 or 4 moist

Chroma: 3 or 4, dry or moist
 Texture: very fine sandy loam, fine sandy loam, loam
 Rock fragments: 35 to 70 percent
 Reaction: slightly to moderately alkaline
 Some pedons have a Bw horizon above the Bk horizon.

124—Toqui gravelly loam, 1 to 8 percent slopes

Map Unit Setting

Landform: plateau
Elevation: 5,000 to 7,230 feet (1,524 to 2,203 meters)
Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)
Mean annual air temperature: 50 to 52 degrees F (10 to 11 degrees C)
Mean annual soil temperature: 52 to 54 degrees F (12 to 13 degrees C)
Frost-free period: 120 to 160 days

Map Unit Composition

Toqui and similar soils: 85 percent
 Minor components: 15 percent

- Soils that are shallow to bedrock
- Soils that are deep to bedrock
- Soils that have accumulation of calcium carbonate in the profile
- Soils that have greater than 35 percent rock fragments in the profile
- Soils that have low amounts of clay in the profile

Properties and Qualities

Toqui soils

Taxonomic classification: Clayey, smectitic, mesic Lithic Haplustalfs
Geomorphic position: summits
Parent material: residuum weathered from cherty limestone
Slope: 1 to 8 percent
Surface fragments: about 10 percent cobbles, about 15 percent gravel
Depth to restrictive feature: 8 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Permeability: about 0.03 in/hr (very slow)
Available water capacity total inches: 2.0
Shrink-swell potential: about 7.0 LEP (high)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet

Runoff class: High
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-6
Ecological site name: Clay Loam Upland, Gravelly (PIED, JUOS) 13-17" p.z.
Ecosystem site number: 035XF611AZ
Present native vegetation: muttongrass, Utah juniper, Wyoming big sagebrush, blue grama, Colorado pinyon
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino plateau; 1.24 miles northeast of Zuni Point, 35 degrees, 59 minutes, 59 seconds north latitude; 111 degrees, 54 minutes, 5 seconds west longitude.

A—0 to 2 inches; strong brown (7.5YR 4/6) gravelly loam; dark brown (7.5YR 3/3) moist; strong fine subangular blocky structure; hard, friable, moderately sticky and moderately plastic; few very fine roots; few very fine tubular pores; 15 percent gravel, 5 percent cobble; slightly effervescent; slightly alkaline (pH 7.8); abrupt smooth boundary.

Bt—2 to 15 inches; reddish brown (5YR 4/4) gravelly clay; reddish brown (5YR 4/4) moist; strong coarse subangular blocky structure; hard, firm, very sticky and very plastic; many fine and few medium roots; common fine tubular pores; common faint clay films lining pores and on faces of peds; 20 percent gravel; slightly effervescent; moderately alkaline (pH 8.0); abrupt irregular boundary.

R—15 inches; cherty limestone bedrock.

Range in Characteristics

Depth to bedrock: 8 to 20 inches

A horizon

Hue: 7.5YR, 10YR
 Value: 3 through 5 dry, 3 or 4 moist
 Chroma: 3 through 6 dry, 2 through 4 moist
 Reaction: slightly acid to slightly alkaline

Bt horizon

Hue: 5YR, 7.5YR
 Value: 3 through 5 dry, 3 or 4 moist
 Chroma: 3 through 6, dry or moist
 Rock fragments: averages 0 to 35 percent, mostly gravel
 Clay content: averages 35 to 50 percent, may be less in some horizons

Some pedons may have Bk or Btk horizons.

125—Toqui-Yumtheska complex, 2 to 30 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,000 to 6,600 feet (1,524 to 2,012 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 50 to 54 degrees F (10 to 12 degrees C)

Mean annual soil temperature: 52 to 56 degrees F (12 to 14 degrees C)

Frost-free period: 120 to 160 days

Map Unit Composition

Toqui and similar soils: 50 percent

Yumtheska and similar soils: 35 percent

Minor components: 15 percent

- Soils that are shallow to bedrock
- Soils that are deep to bedrock
- Soils that have accumulation of calcium carbonate in the profile
- Soils that have greater than 35 percent rock fragments in the profile
- Soils that have low amounts of clay in the profile

Properties and Qualities

Toqui soils

Taxonomic classification: Clayey, smectitic, mesic Lithic Haplustalfs

Geomorphic position: summits

Parent material: residuum weathered from limestone and sandstone

Slope: 2 to 15 percent

Surface fragments: about 25 percent gravel

Depth to restrictive feature: 8 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.13 in/hr (slow)

Available water capacity total inches: 2.5

Shrink-swell potential: about 7.5 LEP (high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Clay Loam Upland, Gravelly (PIED, JUOS) 13-17" p.z.

Ecosystem site number: 035XF611AZ

Present native vegetation: muttongrass, Wyoming big sagebrush, blue grama, *Elymus elymoides* ssp.

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: about 200 feet east and 2,000 feet north of the southwest corner of section 13, T. 30 N., R. 7 W.

A—0 to 2 inches; brown (7.5YR 4/4) very gravelly loam, dark brown (7.5YR 3/4) moist; weak thick platy structure; soft, very friable, nonsticky and slightly plastic; many very fine roots; many very fine vesicular pores; 40 percent gravel; noneffervescent; neutral (pH 7.2); clear smooth boundary.

Bt—2 to 9 inches; reddish brown (5YR 4/4) gravelly clay, dark reddish brown (5YR 3/4) moist; weak medium subangular blocky structure; hard, firm, moderately sticky and moderately plastic; many very fine roots; many fine tubular pores; 15 percent gravel; few faint clay films bridging sand grains; slightly effervescent; neutral (pH 6.9); clear smooth boundary.

Btk1—9 to 12 inches; reddish brown (5YR 4/4) gravelly clay, dark reddish brown (5YR 3/4) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; very hard, very firm, very sticky and very plastic; common fine and medium roots; few fine tubular pores; 15 percent gravel; many faint clay films bridging sand grains; few thin calcium carbonate coatings on rock fragments; many pressure faces; strongly effervescent, 7 percent calcium carbonate equivalent; slightly alkaline (pH 7.4); clear smooth boundary.

Btk1—12 to 17 inches; reddish brown (5YR 5/4) gravelly clay, reddish brown (5YR 4/4) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; very hard, very firm, very sticky and very plastic; many medium roots and few fine roots; few fine tubular pores; 20 percent gravel, 5 percent cobble; many thin clay films bridging sand grains; common thin calcium carbonate coatings on rock fragments; many pressure faces; strongly effervescent, 15 percent calcium carbonate equivalent; slightly alkaline (pH 7.6); abrupt smooth boundary.

2R1—17 to 20 inches; calcium carbonate coated fracture cherty limestone; few fine roots in fractures; abrupt smooth boundary.

2R2—20 inches; cherty limestone.

Range in Characteristics

Depth to bedrock: 8 to 20 inches
Reaction: neutral or slightly alkaline

A horizon

Hue: 7.5YR, 10YR
Value: 3 through 5 dry, 3 or 4 moist
Chroma: 3 through 6 dry, 2 through 4 moist
Reaction: slightly acid to slightly alkaline

Bt horizon

Hue: 5YR, 7.5YR
Value: 3 through 5 dry, 3 or 4 moist
Chroma: 3 through 6, dry or moist
Rock fragments: averages 0 to 35 percent, mostly gravel
Clay content: averages 35 to 50 percent, may be less in some horizons

Some pedons may have Bk or Btk horizons.

Yumtheska soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Calciustolls
Geomorphic position: summits and side slopes of hills and ridges
Parent material: residuum weathered from limestone and sandstone
Slope: 2 to 30 percent
Surface fragments: about 55 percent cobbles, about 15 percent gravel
Depth to restrictive feature: 7 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Permeability: about 1.30 in/hr (moderate)
Available water capacity total inches: 1.4
Shrink-swell potential: about 1.5 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-6
Ecological site name: Limestone Upland (JUOS, PIED) 13-17" p.z.
Ecosystem site number: 035XF619AZ
Present native vegetation: muttongrass, Stansbury cliffrose, blue grama, Wyoming big sagebrush, Elymus elymoides ssp. elymoides, Freemont's mahonia

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: Coconino County, Arizona; on the Hualapai Indian Reservation; 50 feet west and 900 feet south of the northeast corner of Section 14, T. 30 N., R. 7 W.

A—0 to 2 inches; brown (10YR 5/3) extremely cobbly loam, dark brown (10YR 3/3) moist; weak thin platy structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; few fine vesicular pores; 35 percent cobble, 10 percent stones, 30 percent gravel; slightly effervescent, 5 percent calcium carbonate equivalent; slightly alkaline; clear smooth boundary.

Bw—2 to 5 inches; brown (10YR 4/3) very cobbly loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common fine tubular pores; 30 percent cobble and 15 percent gravel; strongly effervescent, 6 percent calcium carbonate equivalent; slightly alkaline; clear smooth boundary.

Bk1—5 to 14 inches; brown (10YR 4/3) very cobbly loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; common fine tubular pores; 35 percent cobble, and 20 percent gravel with calcium carbonate pendants on undersides; violently effervescent, 24 percent calcium carbonate equivalent; moderately alkaline; clear smooth boundary.

Bk2—14 to 17 inches; brown (10YR 4/3) very cobbly loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common medium roots; common fine tubular pores; 30 percent cobble, and 15 percent gravel with calcium carbonate pendants on undersides; violently effervescent, 26 percent calcium carbonate equivalent; moderately alkaline; abrupt smooth boundary.

R—17 inches; limestone.

Range in Characteristics

Rock fragments: average more than 35 percent in the particle size control section
Clay content: averages 18 to 20 percent in the particle size control section
Depth to bedrock: 7 to 20 inches

A horizon

Hue: 7.5YR, 10YR

Value: 3 through 5, dry or moist

Chroma: 2 through 4 dry, 2 or 3 moist

Organic matter: averages 1 to 5 percent in the surface

Bk horizon(s)

Hue: 7.5YR, 10YR

Value: 3 through 7 dry, 3 through 5 moist

Chroma: 2 through 4, dry or moist

Calcium carbonate equivalent: 15 to 40 percent

126—Torriorthents-Haplocalcids-Lava Flows complex, 10 to 40 percent slopes

Map Unit Setting

Landform: hill*Elevation:* 1,600 to 2,500 feet (487 to 762 meters)*Mean annual precipitation:* 6 to 9 inches (152 to 229 millimeters)*Mean annual air temperature:* 64 to 70 degrees F (18 to 21 degrees C)*Mean annual soil temperature:* 66 to 72 degrees F (20 to 23 degrees C)*Frost-free period:* 230 to 320 days

Map Unit Composition

Torriorthents and similar soils: 35 percent

Haplocalcids and similar soils: 30 percent

Lava Flows: 20 percent

Minor components: 15 percent

- Talus slopes of basalt stone and boulders over sedimentary bedrock
- Sandy soils that are shallow to very deep to bedrock
- Loamy, shallow to deep soils in drainageways
- Soils that have an extremely stony or extremely bouldery surface phase

Properties and Qualities

Torriorthents soils

Taxonomic classification: Torriorthents*Geomorphic position:* eroded side slopes of basalt flows and lacustrine sediments*Parent material:* colluvium and/or residuum*Slope:* 10 to 40 percent*Surface fragments:* about 50 percent coarse gravel, about 15 percent cobbles, about 5 percent stones*Depth to restrictive feature:* 20 to 60 inches to bedrock (lithic)*Drainage class:* Well drained*Permeability:* about 0.01 in/hr (very slow)*Available water capacity total inches:* 8.9*Shrink-swell potential:* about 7.0 LEP (high)*Flooding hazard:* None*Seasonal water table minimum depth:* greater than 6 feet*Runoff class:* very high*Hydrologic group:* C*Major Land Resource Area:* 30*Land Resource Unit:* 30-2*Ecological site name:* Basalt Slopes 6-9" p.z.*Ecosystem site number:* 030XB203AZ*Present native vegetation:* white bursage, big galleta, creosotebush, Nevada Mormon tea, white ratany*Land capability (nonirrigated):* 7c

Taxonomic Unit Description

Type Location: In Grand Wash; 36 degrees, 15 minutes, 48 seconds north latitude; 114 degrees, 0 minutes, 1 second west longitude.

A—0 to 3 inches; strong brown (7.5YR 5/6) extremely gravelly very fine sandy loam, strong brown (7.5YR 4/6) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and common medium roots; common very fine and few fine tubular pores; 45 percent gravel, 15 percent cobble, 5 percent stone; strongly effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bw—3 to 14 inches; light reddish brown (5YR 6/4) extremely gravelly sandy loam, yellowish red (5YR 5/6) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; common very fine and fine and few medium roots; common very fine and few fine and medium tubular pores; 70 percent gravel, 5 percent cobble; violently effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

2Bw—14 to 25 inches; yellowish red (5YR 4/6) silty clay, yellowish red (5YR 4/6) moist; moderate coarse prismatic structure; hard, firm, very sticky and moderately plastic; few fine and medium roots; few fine tubular pores; violently effervescent; strongly alkaline (pH 8.6); gradual wavy boundary.

2Cd—25 to 60 inches; yellowish red (5YR 5/6) silty clay, yellowish red (5YR 5/6) moist; massive; hard, firm, very sticky and very plastic; few fine roots, few fine tubular pores; violently effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Parent material: colluvium and residuum from lacustrine sediment

Depth to weathered or unweathered bedrock: 20 to 60 inches

Clay content: 5 to 45 percent; typically the higher clay percentage is in the lower part of the profile

Rock fragments: typically, more than 35 percent in the upper part and less than 35 percent in the lower part

A horizon

Hue: 5YR, 7.5YR

Value: 5 or 6 dry, 4 or 5 moist

Chroma: 3 through 6, dry or moist

Reaction: moderately alkaline to strongly alkaline

Effervescence: slightly to violently effervescent

Calcium carbonate equivalent: 1 to 15 percent

Subsurface horizons

Hue: 5YR, 7.5YR

Value: 4 through 8 dry, 4 or 5 moist

Chroma: 3 through 6, dry or moist

Gypsum: 0 to 15 percent

Reaction: moderately alkaline to strongly alkaline

Effervescence: strongly to violently effervescent

Calcium carbonate equivalent: 5 to 30 percent

Haplocalcids soils

Taxonomic classification: Haplocalcids

Geomorphic position: eroded side slopes of basalt flows and lacustrine sediments

Parent material: colluvium

Slope: 10 to 40 percent

Surface fragments: about 45 percent coarse gravel, about 10 percent cobbles

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 2.9

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: C

Major Land Resource Area: 30

Land Resource Unit: 30-2

Ecological site name: Limy Slopes 6-9" p.z.

Ecosystem site number: 030XB212AZ

Present native vegetation: white bursage, creosotebush, Torrey Mormon tea, white ratany

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 2,596 feet southwest of Azure Ridge Draw; 36 degrees, 15

minutes, 2 seconds north latitude; 114 degrees, 0 minutes, 50 seconds west longitude.

A—0 to 2 inches; light brown (7.5YR 6/4) very gravelly fine sandy loam, strong brown (7.5YR 4/6) moist; weak fine subangular blocky and thin platy structure; soft, very friable, nonsticky and nonplastic; common very fine roots; few very fine tubular and irregular pores; 40 percent gravel, 10 percent cobble; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bk1—2 to 10 inches; pink (7.5YR 7/4) very gravelly fine sandy loam, strong brown (7.5YR 4/6) moist; weak fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine tubular pores; 50 percent gravel, 5 percent cobble; many thick coats and pendants of calcium carbonate on undersides and sides of rock fragments; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bk2—10 to 20 inches; pink (7.5YR 8/3) extremely gravelly loam, light brown (7.5YR 6/4) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine and fine roots; few fine tubular pores; 65 percent gravel; many slightly hard and hard masses of calcium carbonate; many thick coats and pendants of calcium carbonate on undersides and sides of rock fragments; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bk3—20 to 26 inches; pinkish white (7.5YR 8/2) very gravelly loam, light brown (7.5YR 6/4) moist; massive; soft, very friable, slightly sticky and moderately plastic; few very fine and fine roots; few fine tubular pores; 45 percent gravel; many slightly hard and hard masses of calcium carbonate; many thick coats and pendants of calcium carbonate on undersides and sides of rock fragments; violently effervescent; strongly alkaline (pH 8.6); gradual wavy boundary.

2Cy—26 to 60 inches; pink (7.5YR 7/4) gravelly loamy sand, strong brown (7.5YR 5/6) moist; single grain; loose, nonsticky and nonplastic; few fine roots; few fine tubular pores; 20 percent gravel; common medium and coarse gypsum crystals; violently effervescent; moderately alkaline (pH 8.2).

Range in Characteristics

Depth to calcic horizon: 1 to 4 inches

Depth to weathered or unweathered bedrock: 20 to 60 inches

Clay content: 5 to 35 percent; typically the higher clay percentage is in the upper part of the profile

Rock fragments: typically, more than 35 percent

A horizon

Hue: 5YR, 7.5YR

Value: 5 through 7 dry, 4 through 6 moist

Chroma: 3 through 6, dry or moist

Effervescence: slightly to violently effervescent

Calcium carbonate equivalent: 5 to 15 percent

Bk horizons

Hue: 5YR, 7.5YR

Value: 6 through 8 dry, 4 through 6 moist

Chroma: 2 through 6, dry or moist

Reaction: moderately alkaline to strongly alkaline

Effervescence: strongly to violently effervescent

Calcium carbonate equivalent: 15 to 25 percent

Lava Flows

Outcrops of basalt bedrock

127—Torriorthents-Haplogypsids complex, Muddy Creek Formation, 35 to 75 percent slopes

Map Unit Setting

Landform: hill

Elevation: 1,200 to 1,600 feet (366 to 488 meters)

Mean annual precipitation: 3 to 6 inches (76 to 152 millimeters)

Mean annual air temperature: 70 to 75 degrees F (21 to 24 degrees C)

Mean annual soil temperature: 72 to 77 degrees F (23 to 26 degrees C)

Frost-free period: 300 to 360 days

Map Unit Composition

Torriorthents and similar soils: 70 percent

Haplogypsids and similar soils: 30 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Torriorthents soils

Taxonomic classification: Torriorthents

Geomorphic position: ridges and hills of gypsiferous sediments of the Muddy Creek Formation

Parent material: residuum weathered from shale and siltstone

Slope: 50 to 75 percent

Depth to restrictive feature: 4 to 60 inches to bedrock (paralithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 30

Land Resource Unit: 30-1

Ecological site name: Gypsum Hills 3-6" p.z.

Ecosystem site number: 030XA123AZ

Present native vegetation: Fremont indigobush,

Nevada Mormon tea, Torrey Mormon tea

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: 1.05 miles southeast of Pierces Ferry; 36 degrees, 6 minutes, 20 seconds north latitude; 113 degrees, 59 minutes, 3 seconds west longitude.

C—0 to 4 inches; yellowish red (5YR 5/6) very gravelly sandy loam; yellowish red (5YR 4/6) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; common very fine and fine irregular pores; 60 percent gypsum; 50 percent gravel; strongly effervescent; moderately alkaline (pH 8.0); abrupt irregular boundary.

Cr—4 to 60 inches; interbedded gypsum and gypsiferous siltstone.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Haplogypsids soils

Taxonomic classification: Haplogypsids

Geomorphic position: ridges and hills of gypsiferous sediments of the Muddy Creek Formation

Parent material: residuum weathered from shale and siltstone

Slope: 35 to 50 percent

Depth to restrictive feature: 6 to 60 inches to bedrock (paralithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 30

Land Resource Unit: 30-1

Ecological site name: Gypsum Hills 3-6" p.z.
Ecosystem site number: 030XA123AZ
Present native vegetation: Fremont indigobush,
 Nevada Mormon tea, Torrey Mormon tea
Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: 1.25 miles southeast of Pierces Ferry; 36 degrees, 6 minutes, 19 seconds north latitude; 113 degrees, 58 minutes, 45 seconds west longitude.

A—0 to 1 inch; light brown (7.5YR 6/4) extremely gravelly fine sandy loam; brown (7.5YR5/4) moist; moderate thin platy structure; soft, very friable, nonsticky and nonplastic; few very fine roots; common very fine and fine irregular pores; 70 percent gravel; strongly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

By—1 to 8 inches; light brown (7.5YR 6/4) sandy loam; brown (7.5YR 5/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine roots; common very fine irregular pores; many fine gypsum crystals; 10 percent gravel; strongly effervescent; moderately alkaline (pH 8.0); abrupt wavy boundary.

Cy—8 to 23 inches; variegated (7.5YR 6/3 and 5YR 7/2) very gravelly loamy sand; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; common very fine irregular pores; many fine and medium gypsum plates and crystals; 40 percent gravel; strongly effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

R—23 inches; gypsiferous siltstone.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

128—Torriorthents-Lithic Haplargids-Rock outcrop complex, Tonto Group, 15 to 60 percent slopes

Map Unit Setting

Landform: plateau
Elevation: 1,600 to 2,500 feet (488 to 762 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)
Mean annual air temperature: 63 to 68 degrees F (17 to 20 degrees C)
Mean annual soil temperature: 65 to 70 degrees F (19 to 22 degrees C)
Frost-free period: 210 to 280 days

Map Unit Composition

Torriorthents and similar soils: 60 percent
 Lithic Haplargids and similar soils: 25 percent
 Rock outcrop: 15 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Torriorthents soils

Taxonomic classification: Torriorthents
Geomorphic position: fan terraces and alluvial fans
Parent material: colluvium derived from limestone, sandstone, and shale
Slope: 15 to 60 percent
Depth to restrictive feature: 6 to 60 inches to bedrock (lithic)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Major Land Resource Area: 35
Land Resource Unit: 35-5
Ecological site name: Channery Hills 6-10" p.z.
Ecosystem site number: 035XE502AZ
Present native vegetation: Torrey Mormon tea, shadscale saltbush, white brittlebush
Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 345 feet northeast of Deer Creek Falls; 36 degrees, 23 minutes, 21 seconds north latitude; 112 degrees, 30 minutes, 30 seconds west longitude.

A—0 to 1 inch; brown (7.5YR 5/4) extremely bouldery silt loam; dark brown (7.5YR 3/4) moist; weak fine and medium subangular blocky structure; soft, very friable, slightly sticky and moderately plastic; common very fine roots; common fine irregular and tubular pores; 15 percent gravel, 25 percent cobble, 35 percent stone, and 15 percent boulder; violently effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

Bw1—1 to 6 inches; reddish brown (5YR 5/4)

extremely bouldery loam, reddish brown (5YR 4/4) moist; moderate fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine, common fine and few medium roots; common very fine irregular pores; 15 percent gravel, 35 percent cobble, 20 percent stone, and 15 percent boulder; violently effervescent; strongly alkaline (pH 8.6), clear irregular boundary.

Bw2—6 to 60 inches; reddish brown (5YR 4/4) extremely bouldery silt loam; yellowish red (5YR 4/6) moist; moderate medium subangular blocky structure; slightly hard, friable, moderately sticky and slightly plastic; few fine and medium roots, few fine tubular pores; 15 percent gravel, 20 percent cobble, 25 percent stone, and 25 percent boulder; violently effervescent, strongly alkaline (pH 8.6).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Lithic Haplargids soils

Taxonomic classification: Lithic Haplargids

Geomorphic position: nearly flat to steep pediments

Parent material: residuum weathered from arkose

Slope: 15 to 30 percent

Depth to restrictive feature: 10 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Channery Hills 6-10" p.z.

Ecosystem site number: 035XE502AZ

Present native vegetation: Torrey Mormon tea, shadscale saltbush, white brittlebush

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 380 feet southwest of Deer Creek Falls; 36 degrees, 23 minutes, 21 seconds north latitude; 112 degrees, 30 minutes, 30 seconds west longitude.

A1—0 to 2 inches; reddish brown (2.5YR 5/3) very gravelly loamy sand; weak red (2.5YR 4/2) moist;

strong thin platy structure; soft, very friable, nonsticky and nonplastic; few very fine roots; many very fine vesicular pores; 30 percent gravel, 10 percent cobble; violently effervescent, moderately alkaline (pH 8.2); abrupt smooth boundary.

A2—2 to 4 inches; reddish brown (5YR 5/4) very gravelly loamy sand; reddish brown (5YR 4/3) moist; moderate thick platy structure parting to strong very fine granular; soft, very friable, nonsticky and nonplastic; common very fine roots; many very fine vesicular and irregular pores; 40 percent gravel, 5 percent cobble; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bt—4 to 10 inches, reddish brown (5YR 5/3) extremely gravelly sandy clay loam; reddish brown (5YR 4/3) moist; weak fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few fine roots; few very fine tubular pores; common faint clay films lining pores; 50 percent gravel, 20 percent cobble; violently effervescent; moderately alkaline (pH 8.4), abrupt irregular boundary.

R—10 inches; Tapeats sandstone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Rock outcrop

Cliffs and escarpments

129—Torriorthents-Rock outcrop complex, Hermit Formation, 2 to 40 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,100 to 3,700 feet (944 to 1,127 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 200 to 280 days

Map Unit Composition

Torriorthents and similar soils: 70 percent
Rock outcrop: 30 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Torriorthents soils

Taxonomic classification: Torriorthents

Geomorphic position: summits and side slopes of hills and ridges

Parent material: residuum weathered from sandstone and siltstone

Slope: 2 to 40 percent

Depth to restrictive feature: 10 to 50 inches to bedrock (paralithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Mudstone Hills, Gypsiferous 6-10" p.z.

Ecosystem site number: 035XE503AZ

Present native vegetation: shadscale saltbush, anderson wolfberry, Torrey Mormon tea, Opuntia, catclaw acacia

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Esplanade; 5,008 feet southwest of Shults Spring; 36 degrees, 11 minutes, 17 seconds north latitude; 113 degrees, 18 minutes, 42 seconds west longitude.

Cy1—0 to 6 inches; reddish yellow (5YR 7/6) gravelly loamy very fine sand; yellowish red (5YR 5/6) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; common very fine irregular and few fine tubular pores; 10 percent discontinuous horizontal and vertical plates of gypsum crystals; 65 percent gypsum in the matrix; 15 percent gravel; violently effervescent; slightly alkaline (pH 7.8); clear smooth boundary.

Cy2—6 to 17 inches; reddish yellow (5YR 7/6) gravelly loamy very fine sand; yellowish red (5YR 5/8) moist; massive; slightly hard, very friable, nonsticky and

nonplastic; many very fine and common fine roots; many very fine irregular pores; 50 percent crystalline gypsum; 30 percent gravel; violently effervescent; slightly alkaline (pH 7.6); abrupt irregular boundary.

Cry—17 to 60 inches; horizon is 70 percent very hard, fractured gypsiferous siltstone bedrock with 25 percent pockets of weathered siltstone and 5 percent soil in cracks; cracks are 4 to 9 inches apart and 0.25 to 0.5 inch wide; crack sidewalls are coated with a continuous layer of gypsum crystals less than 0.2 inches thick; soil matrix is a dark reddish brown (2.5YR 3/4) loamy coarse sand; dark reddish brown (2.5YR 2.5/4) moist; massive; slightly hard, very friable, nonsticky and nonplastic; many very fine and few fine and medium roots in cracks and pockets; many very fine irregular pores; matrix is 30 percent crystalline gypsum; noneffervescent; slightly alkaline (pH 7.6).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Rock outcrop

Pediments and escarpments consisting of gypsiferous sediments of the Hermit Formation

130—Tovar loam, 2 to 8 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 6,200 to 7,000 feet (1,890 to 2,134 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 50 to 52 degrees F (10 to 11 degrees C)

Mean annual soil temperature: 52 to 54 degrees F (12 to 13 degrees C)

Frost-free period: 120 to 160 days

Map Unit Composition

Tovar and similar soils: 75 percent

Minor components: 25 percent

- Soils that are shallow to bedrock

- Soils that are deep to bedrock
- Soils that have accumulation of calcium carbonate in the profile
- Soils that have greater than 35 percent rock fragments in the profile
- Soils that have low amounts of clay in the profile

Properties and Qualities

Tovar soils

Taxonomic classification: Fine, smectitic, mesic Vertic Paleustalfs

Geomorphic position: summits and side slopes

Parent material: residuum weathered from calcareous sandstone

Slope: 1 to 8 percent

Surface fragments: about 20 percent gravel

Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.03 in/hr (very slow)

Available water capacity total inches: 5.0

Shrink-swell potential: about 17.0 LEP (very high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: High

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Loamy Upland (PIED, JUOS) 13-17" p.z.

Ecosystem site number: 035XF625AZ

Present native vegetation: muttongrass, Colorado pinyon, Wyoming big sagebrush, blue grama, Utah juniper, Gambel oak

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau; 506 feet south of Desert View Point; 36 degrees, 2 minutes, 25 seconds north latitude; 111 degrees, 49 minutes, 26 seconds west longitude.

A—0 to 3 inches; brown (7.5YR 4/4) loam; dark brown (7.5YR 3/3) moist; weak medium subangular blocky structure; soft, very friable, moderately sticky and moderately plastic; many very fine roots; many very fine irregular pores; 10 percent chert gravel; noneffervescent; slightly alkaline (pH 7.8); abrupt smooth boundary.

Bt1—3 to 12 inches; reddish brown (5YR 4/4) gravelly silty clay; reddish brown (5YR 4/4) moist; strong medium subangular blocky structure; hard, firm, very sticky and very plastic; many fine and few medium and

coarse roots; few fine tubular pores; 15 percent chert gravel, 5 percent cobble; common distinct pressure faces, common distinct clay films lining pores and on the faces of peds; noneffervescent; moderately alkaline (pH 8.0); clear smooth boundary.

Bt2—12 to 15 inches; reddish brown (5YR 4/4) gravelly clay; reddish brown (5YR 4/4) moist; strong coarse subangular blocky structure; hard, firm, very sticky and very plastic; many fine and few medium and coarse roots; few fine tubular pores; common distinct clay films on faces of peds; 15 percent chert gravel, 5 percent cobble; many distinct pressure faces; noneffervescent; slightly alkaline (pH 7.6); abrupt smooth boundary.

Bt3—15 to 32 inches; yellowish red (5YR 4/6) clay; yellowish red (5YR 4/6) moist; strong coarse angular blocky structure; very hard, very firm, very sticky and very plastic; few fine and medium roots; few fine tubular pores; few faint clay films on faces of peds; 5 percent chert gravel; many distinct pressure faces; noneffervescent; moderately alkaline (pH 8.0); abrupt irregular boundary.

R—32 inches; cherty sandstone bedrock of the Kaibab Formation

Range in Characteristics

Rock fragments: average 5 to 35 percent in the particle size control section.

Clay content: averages 40 to 55 percent in the particle control section

Depth to bedrock: 20 to 40 inches

Linear extensibility: 6.0 cm or more from the surface horizon to bedrock

A horizon

Hue: 7.5YR, 10YR

Value: 3 through 5 dry, 3 or 4 moist

Chroma: 3 or 4, dry or moist

Reaction: neutral to slightly alkaline

Bt horizon(s)

Hue: 5YR, 2.5YR

Value: 3 through 5 dry, 3 or 4 moist

Chroma: 3 through 6, dry or moist

Reaction: neutral to moderately alkaline

131—Tovar-Toqui-Yumtheska complex, 2 to 8 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,000 to 7,000 feet (1,524 to 2,134 meters)
Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)
Mean annual air temperature: 50 to 52 degrees F (10 to 11 degrees C)
Mean annual soil temperature: 52 to 54 degrees F (12 to 13 degrees C)
Frost-free period: 120 to 160 days

Map Unit Composition

Tovar and similar soils: 40 percent
 Toqui and similar soils: 30 percent
 Yumtheska and similar soils: 15 percent
 Minor components: 15 percent

- Deep and very deep soils that have large amounts of clay and low amounts of rock fragments in the soil
- Shallow and moderately deep soils that have large amounts of rock fragments in the profile
- Shallow soils that have no accumulation of calcium carbonate in the profile
- Moderately deep soils that have accumulation of calcium carbonate in the profile

Properties and Qualities

Tovar soils

Taxonomic classification: Fine, smectitic, mesic Vertic Paleustalfs
Geomorphic position: summits
Parent material: residuum weathered from calcareous sandstone
Slope: 2 to 8 percent
Surface fragments: about 5 percent cobbles, about 10 percent gravel
Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)
Drainage class: Well drained
Permeability: about 0.03 in/hr (very slow)
Available water capacity total inches: 2.6
Shrink-swell potential: about 17.0 LEP (very high)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: very high
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-6
Ecological site name: Loamy Upland (PIED, JUOS) 13-17" p.z.
Ecosystem site number: 035XF625AZ

Present native vegetation: muttongrass, Colorado pinyon, Wyoming big sagebrush, blue grama, Utah juniper, Gambel oak
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau; 1,934 feet south of the National Park Service Training Center; 36 degrees, 2 minutes, 41 seconds north latitude; 112 degrees, 8 minutes, 4 seconds west longitude.

A1—0 to 2 inches; brown (7.5YR 4/4) fine sandy loam; dark brown (7.5YR 3/3) moist; weak very fine and fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine tubular pores; 5 percent gravel, 5 percent cobble; noneffervescent; neutral (pH 6.8); abrupt smooth boundary.

A2—2 to 5 inches; brown (7.5YR 4/4) sandy clay loam; dark brown (7.5YR 3/3) moist; moderate very fine and fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine and few medium roots; many very fine and fine tubular pores; 5 percent gravel; noneffervescent; neutral (pH 6.6); clear smooth boundary.

Bt1—5 to 10 inches; reddish brown (5YR 4/4) gravelly clay; dark reddish brown (5YR 3/4) moist; strong medium subangular blocky structure parting to strong very fine and fine angular blocky; hard, firm, very sticky and very plastic; common fine through coarse roots; common fine and medium tubular pores; many faint clay films and few pressure faces on faces of peds; 15 percent gravel; noneffervescent; neutral (pH 6.6); clear smooth boundary.

Bt2—10 to 21 inches; reddish brown (5YR 5/4) gravelly clay; reddish brown (5YR 4/4) moist; strong fine subangular blocky structure parting to strong very fine angular blocky; hard, firm, very sticky and very plastic; common fine through coarse roots; common fine and medium tubular pores; many faint clay films and few pressure faces on faces of peds; 25 percent gravel; noneffervescent; neutral (pH 7.2); clear wavy boundary.

Bt/Cr—21 to 23 inches; reddish brown (5YR 5/4) very gravelly clay; reddish brown (5YR 4/4) moist; moderate fine angular blocky structure; hard, firm, very sticky and very plastic; few fine roots; few fine tubular pores; many faint clay films on faces of peds; 55 percent gravel; dominantly noneffervescent but with few

strongly effervescent patches; neutral (pH 7.2); abrupt irregular boundary.

R—23 inches; fractured cherty limestone bedrock.

Range in Characteristics

Rock fragments: average 5 to 35 percent in the particle size control section.

Clay content: averages 40 to 55 percent in the particle control section

Depth to bedrock: 20 to 40 inches

Linear extensibility: 6.0 cm or more between the surface horizon and bedrock

A horizon

Hue: 7.5YR, 10YR

Value: 3 through 5 dry, 3 or 4 moist

Chroma: 3 or 4, dry or moist

Reaction: neutral to slightly alkaline

Bt horizon(s)

Hue: 5YR, 2.5YR

Value: 3 through 5 dry, 3 or 4 moist

Chroma: 3 or 4, dry or moist

Reaction: neutral to moderately alkaline

Toqui soils

Taxonomic classification: Clayey, smectitic, mesic Lithic Haplustalfs

Geomorphic position: summits

Parent material: residuum weathered from cherty limestone

Slope: 2 to 8 percent

Surface fragments: about 5 percent gravel

Depth to restrictive feature: 8 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.03 in/hr (very slow)

Available water capacity total inches: 2.4

Shrink-swell potential: about 7.5 LEP (high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Clay Loam Upland, Gravelly (PIED, JUOS) 13-17" p.z.

Ecosystem site number: 035XF611AZ

Present native vegetation: muttongrass, Utah juniper, Wyoming big sagebrush, blue grama, Colorado pinyon

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau; 2,742 feet southwest of Grand Canyon High School; 36 degrees, 2 minutes, 50 seconds north latitude; 112 degrees, 8 minutes, 40 seconds west longitude.

A—0 to 3 inches; brown (7.5YR 4/3) silt loam, dark brown (7.5YR 3/3) moist; moderate fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and common fine roots; many very fine vesicular and common fine tubular pores; 5 percent gravel; slightly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

Bt1—3 to 8 inches; brown (7.5YR 4/3) silty clay loam, dark brown (7.5YR 3/3) moist; strong medium subangular blocky structure; hard, friable, moderately sticky and moderately plastic; common very fine and fine and few medium and coarse roots; common very fine and fine tubular pores; few faint clay films lining pores; 5 percent gravel; slightly effervescent; slightly alkaline (pH 7.4); clear smooth boundary.

Bt2—8 to 11 inches; brown (7.5YR 4/4) clay, brown (7.5YR 4/4) moist; strong medium subangular blocky parting to strong fine angular blocky structure; hard, firm, very sticky and very plastic; common fine through coarse roots; few fine tubular pores; few faint clay films lining pores and on faces of peds; 10 percent gravel; slightly effervescent; slightly alkaline (pH 7.4); clear smooth boundary.

Bt3—11 to 19 inches; brown (7.5YR 4/4) clay, brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; hard, firm, very sticky and very plastic; few fine through coarse roots; few fine tubular pores; common faint clay films lining pores and on faces of peds; 10 percent gravel; slightly effervescent; slightly alkaline (pH 7.6); abrupt smooth boundary.

R—19 inches; hard, calcareous sandstone bedrock.

Range in Characteristics

Depth to bedrock: 8 to 20 inches

A horizon

Hue: 7.5YR, 10YR

Value: 3 through 5 dry, 3 or 4 moist

Chroma: 3 through 6 dry, 2 through 4 moist

Reaction: slightly acid to slightly alkaline

Bt horizon

Hue: 5YR, 7.5YR

Value: 3 through 5 dry, 3 or 4 moist

Chroma: 3 through 6, dry or moist

Rock fragments: averages 0 to 35 percent, mostly gravel

Clay content: averages 35 to 50 percent, may be less in some horizons

Some pedons may have Bk or Btk horizons.

Yumtheska soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Calciustolls

Geomorphic position: summits

Parent material: residuum weathered from limestone and sandstone

Slope: 2 to 8 percent

Surface fragments: about 15 percent gravel, about 5 percent stones, about 40 percent cobbles

Depth to restrictive feature: 7 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 1.1

Shrink-swell potential: about 1.5 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Limestone Upland (JUOS, PIED) 13-17" p.z.

Ecosystem site number: 035XF619AZ

Present native vegetation: Artemisia, Utah juniper, Colorado pinyon, Stansbury cliffrose, green Mormon tea

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau; 2,649 feet north of Moqui Camp, 35 degrees, 59 minutes, 54 seconds north latitude; 112 degrees, 7 minutes, 29 seconds west longitude.

A—0 to 3 inches; brown (7.5YR 4/3) very cobbly loam; dark brown (7.5YR 3/3) moist; moderate medium platy structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and few fine roots; common very fine irregular and fine tubular pores; 10 percent gravel, 40 percent cobble; slightly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

Bk1—3 to 7 inches; brown (7.5YR 4/4) extremely

cobbly loam; dark brown (7.5YR 3/3) moist; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common fine and few medium roots; common fine tubular pores; common thick calcium carbonate coats on undersides of rock fragments; 15 percent gravel, 50 percent cobble; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bk2—7 to 11 inches; dark brown (7.5YR 3/3) extremely flaggy loam; dark brown (7.5YR 3/2) moist; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many fine and few medium roots; common fine tubular pores; thick calcium carbonate coats on the undersides of rock fragments; 15 percent gravel, 10 percent cobble, 50 percent flagstone; violently effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

R—11 inches; Kaibab limestone bedrock.

Range in Characteristics

Rock fragments: average more than 35 percent in the particle size control section

Clay content: averages 18 to 25 percent in the particle size control section

Depth to bedrock: 7 to 20 inches

A horizon

Hue: 7.5YR, 10YR

Value: 3 through 5, dry or moist

Chroma: 2 or 3, dry or moist

Organic matter: averages 1 to 5 percent in the surface

Bk horizon(s)

Hue: 7.5YR, 10YR

Value: 3 through 7 dry, 3 through 5 moist

Chroma: 2 through 4, dry or moist

Calcium carbonate equivalent: 15 to 40 percent

132—Tunitcha-Valto family-Plite family complex, 2 to 15 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 7,980 to 8,540 feet (2,432 to 2,602 meters)

Mean annual precipitation: 25 to 33 inches (635 to 838 millimeters)

Mean annual air temperature: 36 to 45 degrees F (2 to 7 degrees C)

Mean annual soil temperature: 38 to 47 degrees F (4 to 9 degrees C)

Frost-free period: 70 to 105 days

Map Unit Composition

Tunitcha and similar soils: 45 percent

Valto family and similar soils: 40 percent

Plite family and similar soils: 15 percent

Minor components:

- Soils that have no accumulation of clay in the profile
- Soils that have more than 35 percent by volume of rock fragments
- Rock outcrop
- Soils that are shallow to bedrock
- Soils in sinkholes that are very deep and frequently ponded
- Soils in drainageways that are occasionally flooded

Properties and Qualities

Tunitcha soils

Taxonomic classification: Fine-loamy, mixed, superactive, frigid Udic Haplustalfs

Geomorphic position: stream terraces in drainageways

Parent material: alluvium derived from limestone, sandstone, and shale and/or colluvium derived from limestone, sandstone, and shale

Slope: 2 to 8 percent

Surface fragments: about 5 percent gravel

Depth to restrictive feature: 40 to 60 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.13 in/hr (slow)

Available water capacity total inches: 9.0

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Low

Hydrologic group: C

Major Land Resource Area: 35

Land Resource Unit: 35-9

Ecological site name: Loamy Upland 25-33" p.z.

Ecosystem site number: 035XI905AZ

Present native vegetation: mountain muhly, Carex, big wildrye, sheep fescue, pine dropseed

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Kaibab Plateau; 1,865 feet south of Basin Spring; 36 degrees, 15 minutes, 41 seconds north latitude; 112 degrees, 6 minutes, 31 seconds west longitude.

A1—0 to 6 inches; pale brown (10YR 6/3) sandy loam; brown (10YR 4/3) moist; weak very fine subangular blocky structure parting to single grain; soft, very

friable, nonsticky and nonplastic; many very fine and few fine and medium roots; common very fine irregular and common very fine tubular pores; 2 percent gravel; noneffervescent; neutral (pH 6.8); gradual smooth boundary.

A2—6 to 22 inches; pale brown (10YR 6/3) sandy loam; brown (10YR 4/3) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine and few fine and medium roots; common very fine and few fine tubular pores; 2 percent gravel; noneffervescent; neutral (pH 6.8); gradual smooth boundary.

Bt1—22 to 29 inches; pink (7.5YR 7/4) cobbly loam; brown (7.5YR 5/4) moist; weak medium subangular blocky structure parting to moderate fine subangular blocky; soft, very friable, moderately sticky and moderately plastic; few very fine through medium roots; common very fine and few fine tubular pores; common thin clay films lining pores and on the faces of peds, few moderately thick clay films on the faces of peds; 15 percent gravel, 10 percent cobble; noneffervescent; neutral (pH 6.8); clear smooth boundary.

Bt2—29 to 34 inches; pink (7.5YR 7/4) cobbly clay loam; strong brown (7.5YR 5/6) moist; moderate fine and medium subangular blocky structure; slightly hard, very friable, moderately sticky and moderately plastic; few very fine through medium roots; common very fine and few fine tubular pores; common thin clay films on the faces of peds, many thin clay films lining pores, few moderately thick clay films on the faces of peds; 20 percent gravel, 10 percent cobble; noneffervescent; neutral (pH 6.8); clear smooth boundary.

Bt3—34 to 50 inches; yellowish red (5YR 5/6) clay loam; yellowish red (5YR 4/6) and yellowish red (5YR 5/6) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, friable, moderately sticky and very plastic; few very fine through medium roots; few very fine and fine tubular pores; common thin clay films on the faces of peds, many thin clay films lining pores, few moderately thick clay films on the faces of peds; matrix contains 10 percent brownish yellow (10YR 6/6) gravel- and cobble-sized pockets of highly weathered sandstone; noneffervescent, neutral (pH 7.0); gradual smooth boundary.

Bt4—50 to 58 inches; yellowish red (5YR 5/6) clay loam; yellowish red (5YR 4/6) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, friable, moderately sticky moderately plastic; few very fine and fine roots; few very fine and fine tubular pores; common thin clay

films lining pores and on the faces of peds, few moderately thick clay films on the faces of peds; matrix contains 10 percent brownish yellow (10YR 6/6) gravel- and cobble-sized pockets of highly weathered sandstone; noneffervescent; neutral (pH 7.2); abrupt wavy boundary.

R—58 inches; hard sandstone bedrock.

Range in Characteristics

This soil is a taxadjunct to the official series because it has a udic ustic soil moisture regime. Use and management are not affected.

Depth to bedrock: 40 to 60 inches

Depth to base of argillic horizon: 30 to 42 inches

Reaction: slightly acid or neutral

A horizon(s)

Hue: 7.5YR, 10YR

Value: 3 through 7 dry, 2 through 4 moist

Chroma: 2 or 3, dry or moist

Organic carbon content: 1 to 2 percent

Bt horizon(s)

Hue: 7.5YR, 5YR, 10YR

Value: 4 through 6 dry, 3 through 5 moist

Chroma: 3 through 6, dry or moist

Organic carbon content: less than 0.6 percent

Clay content: 28 to 35 percent

Valto family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, nonacid, frigid Lithic Ustorthents

Geomorphic position: summits and sideslopes of low hills and ridges

Parent material: residuum weathered from sandstone

Slope: 2 to 15 percent

Surface fragments: about 5 percent gravel, about 40 percent cobbles

Depth to restrictive feature: 6 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 13.00 in/hr (rapid)

Available water capacity total inches: 0.6

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: High

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-9

Ecological site name: Loamy Hills, Cold (ABLA, PIEN) 25-33" p.z.

Ecosystem site number: 035XI903AZ

Present native vegetation: Engelmann spruce, quaking aspen, subalpine fir, Douglas-fir, other coniferous trees

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Kaibab Plateau; 2,805 feet northeast of Basin Spring; 36 degrees, 15 minutes, 43 seconds north latitude; 112 degrees, 5 minutes, 58 seconds west longitude.

A—0 to 2 inches; brown (7.5YR 5/4) very cobbly fine sandy loam; dark brown (7.5YR 3/4) moist; weak thin platy structure parting to weak very fine subangular blocky; soft, very friable, nonsticky and nonplastic; many very fine roots; common very fine tubular pores; 5 percent gravel, 40 percent cobble; noneffervescent; neutral (pH 6.9); clear smooth boundary.

Bw1—2 to 5 inches; brown (7.5YR 5/4) very cobbly fine sandy loam; brown (7.5YR 4/4) moist; moderate very fine and fine subangular blocky structure; soft, very friable, slightly sticky and nonplastic; many very fine and few fine roots; common very fine tubular pores; 5 percent gravel, 40 percent cobble; noneffervescent; neutral (pH 7.0); clear wavy boundary.

Bw2—5 to 10 inches; brown (7.5YR 5/4) very cobbly fine sandy loam; brown (7.5YR 4/4) moist; moderate very fine and fine subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; common very fine and few fine roots; common very fine tubular pores; 5 percent gravel, 50 percent cobble; noneffervescent; neutral (pH 7.0); abrupt irregular boundary.

R—10 inches; hard, fractured sandstone bedrock.

Range in Characteristics

Depth to bedrock: 6 to 20 inches

Rock fragments: 35 to 70 in the particle size control section

Clay content: 5 to 18 percent in the particle size control section

Reaction: slightly acid or neutral.

A horizon

Hue: 7.5YR through 2.5YR

Value: 4 through 6 dry, 2 through 4 moist

Chroma: 2 through 4, dry or moist

B horizons

Hue: 7.5YR through 2.5YR

Value: 5 through 7 dry, 4 through 6 moist

Chroma: 2 through 4, dry or moist

Plite family soils

Taxonomic classification: Coarse-loamy, mixed, superactive, frigid Cumulic Haplustolls

Geomorphic position: fan terraces at the toe slopes of hills and escarpments

Parent material: alluvium

Slope: 2 to 15 percent

Surface fragments: about 5 percent gravel

Depth to restrictive feature: 40 to 60 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 6.6

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: High

Hydrologic group: B

Major Land Resource Area: 35

Land Resource Unit: 35-9

Ecological site name: Loamy Upland 25-33" p.z.

Ecosystem site number: 035XI905AZ

Present native vegetation: mountain muhly, Carex, big wildrye, sheep fescue, pine dropseed

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Kaibab Plateau; 3,411 feet northeast of Basin Spring; 36 degrees, 15 minutes, 32 seconds north latitude; 112 degrees, 6 minutes, 1 second west longitude.

A1—0 to 4 inches; brown (7.5YR 5/3) sandy loam; dark brown (7.5YR 3/2) moist; weak very fine and fine subangular blocky structure parting to single grain; loose; slightly sticky and nonplastic; many very fine and few fine and medium roots; common very fine tubular pores; 2 percent gravel; noneffervescent; neutral (pH 6.9); gradual smooth boundary.

A2—4 to 16 inches; brown (7.5YR 5/3) sandy loam; dark brown (7.5YR 3/2) moist; weak fine and medium subangular blocky structure; soft, very friable, slightly sticky and nonplastic; common very fine and few fine and medium roots; common very fine tubular pores; 2 percent gravel; noneffervescent; neutral (pH 6.9); gradual smooth boundary.

AB—16 to 29 inches; brown (7.5YR 4/3) sandy loam; dark brown (7.5YR 3/2) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and few fine and medium roots; common very fine tubular

pores; 2 percent gravel; noneffervescent; neutral (pH 6.9); clear smooth boundary.

Bw1—29 to 40 inches; brown (7.5YR 5/3) sandy loam; dark brown (7.5YR 3/2) moist; weak coarse subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few very fine through medium roots; common very fine tubular pores; few thin clay films bridging sand grains; 10 percent stratified gravel; noneffervescent; neutral (pH 6.9); clear smooth boundary.

Bw2—40 to 54 inches; brown (7.5YR 5/3) sandy loam; brown (7.5YR 4/3) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few fine and medium roots; common very fine and few fine tubular pores; few thin clay films bridging sand grains; 10 percent stratified gravel; noneffervescent; neutral (pH 6.9); clear wavy boundary.

C—54 to 64 inches; brown (7.5YR 5/3) sandy loam; brown (7.5YR 4/3) moist; weak very fine subangular blocky structure parting to single grain; loose; nonsticky and nonplastic; few fine and medium roots; many very fine irregular pores; 10 percent gravel; noneffervescent; neutral (pH 6.9).

Range in Characteristics

Thickness of the mollic epipedon: 16 to 38 inches

Depth to bedrock: 40 to 60 inches or more

Reaction: moderately acid to neutral

A horizon

Hue: 7.5YR, 10YR

Value: 4 or 5 dry, 2 or 3 moist

Chroma: 2 or 3, dry or moist

Bw horizons

Hue: 7.5YR, 10YR

Value: 3 through 6 dry, 3 through 5 moist

Chroma: 2 through 4, dry or moist

Clay content: 8 to 20 percent

Rock fragments: 0 to 25 percent gravel

133—Twist very cobbly loam, 1 to 8 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,000 to 5,000 feet (1,219 to 1,524 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 55 to 57 degrees F (13 to 14 degrees C)

Mean annual soil temperature: 57 to 59 degrees F 15 to 16 degrees C)

Frost-free period: 180 to 195 days

Map Unit Composition

Twist and similar soils: 75 percent

Minor components: 25 percent

- Nutter soils
- Soils that have a gravelly, very gravelly, or very stony surface

Properties and Qualities

Twist soils

Taxonomic classification: Fine-loamy, mixed, superactive, mesic Calcic Argigypsis

Geomorphic position: stream terraces of intermittent ways

Parent material: alluvium

Slope: 1 to 8 percent

Surface fragments: about 5 percent stones, about 20 percent cobbles, about 25 percent coarse gravel

Drainage class: Well drained

Permeability: about 0.40 in/hr (moderately slow)

Available water capacity total inches: 8.7

Shrink-swell potential: about 4.5 LEP (moderate)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Medium

Hydrologic group: B

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Clay Loam Upland 6-10" P.z.

Ecosystem site number: 035XE520AZ

Present native vegetation: galleta, Nevada Mormon tea, black grama, Mexican bladdersage, bush muhly

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In Whitmore Canyon; about 200 feet north and 1,050 feet west of the southeast corner of section 3, T. 33 N., R. 9 W.

A—0 to 2 inches, light reddish brown (5YR 6/4) very cobbly loam, reddish brown (5YR 4/4) moist; moderate moderately thick platy structure parting to moderate fine granular; soft, very friable, slightly sticky and nonplastic; 30 percent gravel, 20 percent cobble, and 5 percent stone; strongly effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bt—2 to 11 inches; light reddish brown (5YR 6/4) clay loam, reddish brown (5YR 4/4) moist; moderate medium subangular blocky structure; hard, friable, moderately sticky and moderately plastic; common thin clay films on faces of peds and lining pores; common fine soft seams of calcium carbonate; 5 percent gravel; violently effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

Btk—11 to 25 inches; light reddish brown (5YR 6/4) clay loam, reddish brown (5YR 4/4) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, very sticky and moderately plastic; common thin clay films on faces of peds and lining pores; common fine soft masses and soft seams of calcium carbonate; common fine calcium carbonate pendants on the undersides of rock fragments; 5 percent gravel; violently effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

2By—24 to 64 inches; light reddish brown (5YR 6/4) cobbly loam; reddish brown (5YR 4/4) moist; massive; hard, friable, slightly sticky and slightly plastic; 25 percent crystalline gypsum; 10 percent gravel; 10 percent cobble; violently effervescent; slightly alkaline (pH 7.8).

Range in Characteristics

Depth to base of argillic: 15 to 20 inches

Depth to calcic horizon: 15 to 20 inches

Depth to gypsic horizon: 30 to 39 inches

Rock fragments: less than 15 percent

Organic matter: less than 1 percent in the surface horizon

A horizon:

Hue: 5YR, 7.5YR

Value: 5 through 7 dry, 3 through 5 moist

Chroma: 3 through 6, dry or moist

Calcium carbonate equivalent: 1 to 15 percent

Bt and Btk horizons:

Hue: 5YR, 7.5YR

Value: 5 through 7 dry, 3 through 5 moist

Chroma: 4 through 6, dry or moist

Calcium carbonate equivalent: 1 to 20 percent

Bk horizon:

Hue: 5YR, 7.5YR

Value: 6 through 8 dry, 5 through 8 moist

Chroma: 2 through 6, dry or moist

Reaction: moderately alkaline to strongly alkaline (pH 7.9 to 9.0)

Calcium carbonate equivalent: 15 to 60 percent

2By horizon:

Value: 6 through 8, dry or moist

Chroma: 0 through 6, dry or moist

Gypsum: 5 to 80 percent

Calcium carbonate equivalent: 1 to 30 percent

134—Typic Calciargids-Lava Flows complex, 2 to 30 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 2,500 to 4,500 feet (762 to 1,372 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 210 to 280 days

Map Unit Composition

Typic Calciargids and similar soils: 70 percent

Lava Flows: 30 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Typic Calciargids soils

Taxonomic classification: Typic Calciargids

Geomorphic position: depressions between pressure ridges of basalt flows

Parent material: residuum weathered from basalt

Slope: 2 to 30 percent

Depth to restrictive feature: 20 to 60 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Basalt Hills 6-10" p.z.

Ecosystem site number: 035XE501AZ

Present native vegetation: ephedra, catclaw acacia, blue threeawn, rayless brittlebush, Ferocactus

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In Whitmore Canyon; 1.35 miles northeast of Paws Pocket; 36 degrees, 11 minutes, 55 seconds north latitude; 113 degrees, 12 minutes, 15 seconds west longitude.

A1—0 to 2 inches; light yellowish brown (10YR 6/4) extremely gravelly loam; brown (10YR 4/3) moist; moderate thin platy structure; slightly hard, very friable, moderately sticky and moderately plastic; few very fine roots; many very fine and fine vesicular pores; 55 percent gravel, 5 percent cobble, and 5 percent stone; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

A2—2 to 7 inches; pale brown (10YR 6/3) very cobbly loam; brown (10YR 4/3) moist; strong thin platy structure; slightly hard, very friable, moderately sticky and moderately plastic; few very fine roots; many very fine vesicular pores; 25 percent gravel, 15 percent cobble; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Btk1—7 to 13 inches; brown (7.5YR 5/4) very cobbly silty clay loam; brown (7.5YR 4/3) moist; strong medium subangular blocky structure; slightly hard, very friable, moderately sticky and moderately plastic; common very fine through coarse roots; many very fine and fine, common medium and few coarse tubular pores; few faint clay films on faces of peds and lining pores; common soft fine masses and filaments of calcium carbonate; common thin calcium carbonate coats on undersides of rock fragments; 20 percent gravel, 25 percent cobble; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Btk2—13 to 24 inches; brown (7.5YR 5/3) very cobbly silty clay loam; brown (7.5YR 4/3) moist; strong medium subangular blocky structure; slightly hard, very friable, very sticky and moderately plastic; common fine through coarse roots; many very fine and fine, common medium and few coarse tubular pores; few faint clay films on faces of peds and lining pores; common fine soft masses and filaments of calcium carbonate; common thin calcium carbonate coats on the undersides of rock fragments; 15 percent gravel, 25 percent cobble, and 5 percent stone; violently effervescent; strongly alkaline (pH 8.6); clear smooth boundary.

Btkz—24 to 38 inches; brown (7.5YR 5/4) cobbly clay; brown (7.5YR 4/4) moist; strong fine subangular blocky structure; hard, very friable, very sticky and very plastic; few fine and medium roots; few fine and medium tubular pores; common distinct clay films on

faces of peds and lining pores; many coarse soft masses of calcium carbonate; common thin calcium carbonate coats on the underside of rock fragments; 5 percent gravel, 20 percent cobble, and 5 percent stone; violently effervescent; very strongly alkaline (pH 9.2); abrupt irregular boundary.

R—38 inches; basalt bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as

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violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bk2—24 to 33 inches; yellowish red (5YR 5/6) silt loam; yellowish red (5YR 4/6) moist; strong fine and medium subangular blocky structure; hard, friable, very sticky and very plastic; common fine and medium roots; common very fine through medium tubular pores; common medium and coarse soft filaments and masses of calcium carbonate; 5 percent gravel; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

R—33 inches; sandstone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

136—Typic Haplocalcids, 15 to 55 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,500 to 5,000 feet (1,372 to 1,524 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 55 to 57 degrees F (13 to 14 degrees C)

Mean annual soil temperature: 57 to 59 degrees F (15 to 16 degrees C)

Frost-free period: 180 to 195 days

Map Unit Composition

Typic Haplocalcids and similar soils: 100 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Typic Haplocalcids soils

Taxonomic classification: Typic Haplocalcids

Geomorphic position: summits and sideslopes of fan terraces on canyon escarpments

Parent material: colluvium derived from limestone

Slope: 15 to 55 percent

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Slopes 6-10" p.z.

Ecosystem site number: 035XE507AZ

Present native vegetation: black grama, desert needlegrass, blackbrush, blue threeawn, ephedra, Opuntia

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Tonto Platform; 2,776 feet northeast of Indian Garden; 36 degrees, 4 minutes, 55 seconds north latitude; 112 degrees, 6 minutes, 41 seconds west longitude.

A—0 to 1 inch; pinkish gray (7.5YR 7/2) extremely bouldery silt loam; light brown (7.5YR 6/3) moist; moderate thin platy structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine vesicular pores; 35 percent gravel, 15 percent cobble, 10 percent stone, and 15 percent boulder; violently effervescent; strongly alkaline (pH 8.6); abrupt smooth boundary.

Bw—1 to 3 inches; light brown (7.5YR 6/4) extremely bouldery silt loam; brown (7.5YR 5/4) moist; moderate fine and medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine roots; common very fine and few fine tubular pores; 35 percent gravel, 15 percent cobble, 10 percent stone, and 15 percent boulder; violently effervescent; strongly alkaline (pH 8.6); abrupt irregular boundary.

Bk1—3 to 24 inches; pinkish white (7.5YR 8/2) extremely bouldery loam; pinkish gray (7.5YR 7/2) moist; massive; hard, firm, slightly sticky and slightly plastic; common very fine and fine roots; few very fine and fine tubular pores; weakly cemented by calcium carbonate; 30 percent gravel, 25 percent cobble, 10 percent stone, and 10 percent boulder; violently effervescent; strongly alkaline (pH 8.6); abrupt irregular boundary.

Bk2—24 to 60 inches; pink (7.5YR 8/3) extremely gravelly loam; pinkish gray (7.5YR 7/2) moist; massive; very hard, very firm, slightly sticky and slightly plastic; common very fine and few fine roots;

few very fine tubular pores; weakly to moderately cemented by calcium carbonate; 35 percent gravel, 15 percent cobble, 5 percent stone, and 10 percent boulder; violently effervescent; strongly alkaline (pH 8.6).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

137—Typic Haplocalcids-Typic Calciargids complex, 2 to 15 percent slopes

Map Unit Setting

Landform: stream terrace

Elevation: 3,500 to 4,500 feet (1,067 to 1,372 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 200 to 240 days

Map Unit Composition

Typic Haplocalcids and similar soils: 60 percent

Typic Calciargids and similar soils: 40 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Typic Haplocalcids soils

Taxonomic classification: Typic Haplocalcids

Geomorphic position: stream terrace

Parent material: alluvium

Slope: 2 to 15 percent

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Sandy Loam Terrace 6-10" p.z.

Ecosystem site number: 035XE513AZ

Present native vegetation: Apache plume, Opuntia, catclaw acacia, sand dropseed, ephedra

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 2,500 feet southwest of Tanner Rapids; 36 degrees, 5 minutes, 56 seconds north latitude; 111 degrees, 50 minutes, 34 seconds west longitude.

A—0 to 2 inches; pale brown (10YR 6/3) very stony sandy loam; brown (10YR 4/3) moist; weak fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine tubular pores; 15 percent gravel, 20 percent cobble, and 15 percent stone; strongly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

Bw—2 to 8 inches; light yellowish brown (10YR 6/4) very stony sandy loam; yellowish brown (10YR 5/4) moist; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common very fine and fine and few medium roots; common very fine and fine tubular pores; 20 percent gravel, 15 percent cobble, and 20 percent stone; strongly effervescent; moderately alkaline (pH 8.2); clear wavy boundary.

Bk—8 to 60 inches; very pale brown (10YR 7/4) very stony loam; light yellowish brown (10YR 6/4) moist; moderate medium subangular blocky structure; hard, friable, nonsticky and nonplastic; few very fine and fine roots; few fine tubular pores; weakly cemented by calcium carbonate; many calcium carbonate coats and pendants on the undersides and sides of rock fragments; 15 percent gravel, 15 percent cobble, and 20 percent stone; violently effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined.

Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Typic Calciargids soils

Taxonomic classification: Typic Calciargids

Geomorphic position: stream terraces

Parent material: alluvium

Slope: 2 to 15 percent

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Sandy Loam Terrace 6-10" p.z.

Ecosystem site number: 035XE513AZ

Present native vegetation: Apache plume, Opuntia, catclaw acacia, sand dropseed, ephedra

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 1.55 miles southwest of Espero Butte; 36 degrees, 7 minutes, 10 seconds north latitude; 111 degrees, 49 minutes, 15 seconds west longitude.

A—0 to 1 inch; light brown (7.5YR 6/4) extremely stony fine sandy loam; brown (7.5YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; many very fine vesicular and few very fine tubular pores; 30 percent gravel, 15 percent cobble, 15 percent stones violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Btk1—1 to 3 inches; light reddish brown (5YR 6/4) very cobbly loam, yellowish red (5YR 4/6) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine and few fine roots; common very fine and few fine tubular pores; few faint clay films lining pores; many thick coats and pendants of calcium carbonate on the undersides of rock fragments; 20 percent gravel, 15 percent cobble, 10 percent stone; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Btk2—3 to 14 inches; yellowish red (5YR 5/6) extremely gravelly sandy clay loam, yellowish red (5YR 4/6) moist; strong fine and medium subangular blocky structure; slightly hard, very friable, sticky and very plastic; few very fine through coarse roots; few very fine and fine tubular pores; common faint clay

films bridging sand grains and lining pores; common fine soft masses and seams of calcium carbonate; 50 percent gravel, 10 percent cobble, 5 percent stone; violently effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

Bk—14 to 24 inches; light reddish brown (5YR 6/4) very gravelly sandy loam, reddish brown (5YR 5/4) moist; weak fine and medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; few very fine through coarse roots; few very fine and fine tubular pores; common soft masses of calcium carbonate; 40 percent gravel, 10 percent cobble, 5 percent stone; violently effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

2C—30 to 60 inches; light brown (7.5YR 6/4) stratified extremely gravelly sandy loam to very cobbly loamy sand, strong brown (7.5YR 4/6) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; common very fine interstitial pores; violently effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

138—Typic Haplocalcids-Typic Petrocalcids complex, 15 to 25 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,500 to 4,900 feet (1,371 to 1,493 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 55 to 57 degrees F (13 to 14 degrees C)

Mean annual soil temperature: 57 to 59 degrees F (15 to 16 degrees C)

Frost-free period: 180 to 195 days

Map Unit Composition

Typic Haplocalcids and similar soils: 60 percent

Typic Petrocalcids and similar soils: 40 percent

Because of the extreme inaccessibility of the map unit,

only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Typic Haplocalcids soils

Taxonomic classification: Typic Haplocalcids

Geomorphic position: inset fans on fan terraces on plateau escarpments

Parent material: alluvium

Slope: 15 to 25 percent

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Sandy Loam Upland 6-10" p.z.

Ecosystem site number: 035XE514AZ

Present native vegetation: black grama, bush muhly, desert needlegrass, banana yucca, catclaw acacia, green Mormon tea

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Esplanade; 1,921 feet north of Sage Flat Reservoir; 36 degrees, 12 minutes, 33 seconds north latitude; 113 degrees, 10 minutes, 5 seconds west longitude.

A1—0 to 1 inch; brown (10YR 5/3) extremely gravelly sandy loam; dark brown (10YR 3/2) moist; weak very fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine and common medium roots; many very fine and fine tubular pores; 60 percent gravel; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

A2—1 to 4 inches; brown (10YR 5/3) extremely gravelly sandy loam; brown (10YR 4/3) moist; weak very fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine through medium roots; common very fine and fine tubular pores; 70 percent gravel; violently effervescent; moderately alkaline (pH 8.4); abrupt wavy boundary.

Bk1—4 to 18 inches; reddish brown (7.5YR 5/4) very gravelly silt loam; reddish brown (7.5YR 4/3) moist; moderate fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine through medium roots; common fine tubular pores; many thick calcium carbonate coats and pendants on the undersides of rock fragments; 50

percent gravel; violently effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

Bk2—18 to 60 inches; light reddish brown (7.5YR 6/4) very gravelly silt loam; reddish brown (7.5YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common fine and medium roots; common fine tubular pores; many thick calcium carbonate coats and pendants on the undersides of rock fragments; 40 percent gravel; violently effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Typic Petrocalcids soils

Taxonomic classification: Typic Petrocalcids

Geomorphic position: summits and side slopes of fan terraces on plateau escarpments

Parent material: alluvium derived from limestone

Slope: 15 to 25 percent

Depth to restrictive feature: 4 to 10 inches to petrocalcic

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Upland, Shallow 6-10" p.z.

Ecosystem site number: 035XE519AZ

Present native vegetation: blackbrush, ephedra, Opuntia, banana yucca

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Esplanade; 5,253 feet northeast of Paws Pocket; 36 degrees, 12 minutes, 10 seconds north latitude; 113 degrees, 12 minutes, 28 seconds west longitude.

A—0 to 2 inches; brown (7.5YR 5/4) very gravelly loam; dark brown (7.5YR 3/4) moist; weak medium platy and strong fine granular structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; common very fine and few fine irregular and few very fine tubular pores; 45 percent gravel, 5 percent

cobble; violently effervescent; moderately alkaline (pH 8.4); abrupt wavy boundary.

Bk—2 to 6 inches; brown (7.5YR 5/4) very gravelly loam; dark brown (7.5YR 3/4) moist; weak medium and strong fine subangular blocky structure; slightly hard, very friable, slightly sticky and moderately plastic; common very fine and few fine through coarse roots; common very fine and few fine tubular and irregular pores; few thin calcium carbonate coats on faces of peds; 30 percent gravel, 5 percent cobble; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bkm—6 inches; indurated petrocalcic with 1/4-inch thick laminar cap.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

139—Typic Haplocalcids-Typic Torriorthents complex, 2 to 15 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,200 to 3,700 feet (975 to 1,127 meters)

Mean annual precipitation: 6 to 10 inches (153 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 200 to 240 days

Map Unit Composition

Typic Haplocalcids and similar soils: 70 percent

Typic Torriorthents and similar soils: 30 percent

Properties and Qualities

Typic Haplocalcids soils

Taxonomic classification: Typic Haplocalcids

Geomorphic position: summits and side slopes of fan terraces on colluvial slopes of escarpments

Parent material: alluvium and/or colluvium derived from limestone and sandstone

Slope: 2 to 15 percent

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Sandy Loam Upland 6-10" p.z.

Ecosystem site number: 035XE514AZ

Present native vegetation: black grama, bush muhly, desert needlegrass, banana yucca, catclaw acacia, green Mormon tea

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In Whitmore Canyon; 1.44 miles east of Whitmore Point; 36 degrees, 11 minutes, 5 seconds north latitude; 113 degrees, 14 minutes, 10 seconds west longitude.

A—0 to 2 inches; strong brown (7.5YR 5/6) gravelly very fine sandy loam; dark brown (7.5YR 3/4) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine and fine root; many very fine and fine tubular and irregular pores; 30 percent gravel; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bw—2 to 15 inches; light brown (7.5YR 6/4) gravelly very fine sandy loam; brown (7.5YR 4/4) moist; strong medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine through medium roots; many very fine through medium tubular pores; 15 percent gravel; violently effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

Bk—15 to 31 inches; pink (7.5YR 7/4) extremely cobbly coarse sandy loam; strong brown (7.5YR 5/6) moist; massive; slightly hard; friable, slightly sticky and nonplastic; few patches of many very fine roots occur beneath rock fragments; few fine tubular pores; 25 percent gravel, 50 percent cobble; common thin calcium carbonate coats on the undersides of rock fragments; violently effervescent; strongly alkaline (pH 8.6); clear wavy boundary.

2Bk—31 to 60 inches; reddish yellow (7.5YR 6/6) gravelly loam; strong brown (7.5YR 5/6) moist; massive; soft, very friable, moderately sticky and slightly plastic; few very fine and fine roots; few fine tubular pores; 30 percent gravel; common thin calcium carbonate coats on the undersides of rock

fragments; violently effervescent; strongly alkaline (pH 8.6).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Typic Torriorthents soils

Taxonomic classification: Typic Torriorthents

Geomorphic position: drainageways

Parent material: alluvium and/or colluvium derived from limestone, sandstone, and shale

Slope: 2 to 15 percent

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Sandy Wash 6-10" p.z.

Ecosystem site number: 035XE511AZ

Present native vegetation: Sporobolus, Apache plume, longleaf brickellbush, alkali jimmyweed, cane beardgrass

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In Whitmore Canyon; 1,594 feet southwest of Paws Pocket; 36 degrees, 12 minutes, 42 seconds north latitude; 113 degrees, 13 minutes, 11 seconds west longitude.

A—0 to 2 inches; brown (7.5YR 5/4) very cobbly fine sandy loam; strong brown (7.5YR 4/6) moist; weak thin platy structure; soft, very friable, nonsticky and nonplastic; many very fine and few fine roots; common very fine irregular and few very fine and fine tubular pores; 30 percent gravel, 20 percent cobble; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

C—2 to 60 inches; brown (7.5YR 5/4) stratified extremely stony coarse sand to extremely gravelly loamy coarse sand; dark brown (7.5YR 3/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots, few very fine and fine tubular and

irregular pores; 35 percent gravel, 30 percent cobble, 10 percent stone; violently effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

140—Typic Haplogypsids, Hermit Formation, 8 to 15 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,500 to 5,000 feet (1,372 to 1,524 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 55 to 57 degrees F (13 to 14 degrees C)

Mean annual soil temperature: 57 to 59 degrees F (15 to 16 degrees C)

Frost-free period: 180 to 195 days

Map Unit Composition

Typic Haplogypsids and similar soils: 100 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Typic Haplogypsids soils

Taxonomic classification: Typic Haplogypsids

Geomorphic position: hills and ridges of gypsiferous sediments on the Hermit Formation

Parent material: alluvium derived from sandstone and shale and/or alluvium derived from siltstone and/or residuum weathered from sandstone and shale and/or residuum weathered from siltstone

Slope: 8 to 15 percent

Depth to restrictive feature: 20 to 60 inches to bedrock (paralithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Mudstone Hills, Gypsiferous 6-10" p.z.

Ecosystem site number: 035XE503AZ

Present native vegetation: shadscale saltbush, anderson wolfberry, Torrey Mormon tea, Opuntia, catclaw acacia

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Esplanade; 5,008 feet southwest of Shults Spring; 36 degrees, 11 minutes, 17 seconds north latitude; 113 degrees, 18 minutes, 42 seconds west longitude.

Cy1—0 to 6 inches; reddish yellow (5YR 7/6) gravelly loamy very fine sand; yellowish red (5YR 5/6) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; common very fine irregular and few fine tubular pores; 10 percent discontinuous horizontal and vertical plates of gypsum crystals; 65 percent gypsum in the matrix; 15 percent gravel; violently effervescent; slightly alkaline (pH 7.8); clear smooth boundary.

Cy2—6 to 17 inches; reddish yellow (5YR 7/6) gravelly loamy very fine sand; yellowish red (5YR 5/8) moist; massive; slightly hard, very friable, nonsticky and nonplastic; many very fine and common fine roots; many very fine irregular pores; 50 percent crystalline gypsum; 30 percent gravel; violently effervescent; slightly alkaline (pH 7.6); abrupt irregular boundary.

Cry—17 to 60 inches; horizon is 70 percent very hard, fractured gypsiferous siltstone bedrock with 25 percent pockets of weathered siltstone and 5 percent soil in cracks; cracks are 4 to 9 inches apart and 0.25 to 0.5 inches wide; crack sidewalls are coated with a continuous layer of gypsum crystals less than 0.2 inches thick; soil matrix is a dark reddish brown (2.5YR 3/4) loamy coarse sand; dark reddish brown (2.5YR 2.5/4) moist; massive; slightly hard, very friable, nonsticky and nonplastic; many very fine and few fine and medium roots in cracks and pockets; many very fine irregular pores; matrix is 30 percent crystalline gypsum; noneffervescent; slightly alkaline (pH 7.6).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access,

statistically valid data could not be determined.

Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

141—Typic Petrocalcids-Haplogypsid-Rock outcrop complex, Hermit Formation, 8 to 45 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,400 to 3,600 feet (1,036 to 1,097 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 200 to 240 days

Map Unit Composition

Typic Petrocalcids and similar soils: 55 percent

Haplogypsid and similar soils: 25 percent

Rock outcrop: 20 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Typic Petrocalcids soils

Taxonomic classification: Typic Petrocalcids

Geomorphic position: summits and sideslopes of colluvial fan terraces at the base of escarpments

Parent material: colluvium derived from limestone and sandstone

Slope: 8 to 45 percent

Depth to restrictive feature: 3 to 10 inches to petrocalcic

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Upland, Shallow 6-10" p.z.

Ecosystem site number: 035XE519AZ

Present native vegetation: blackbrush, ephedra, Opuntia, banana yucca

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In Whitmore Canyon; 1.34 miles northeast of Whitmore Point; 36 degrees, 10 minutes, 30 seconds north latitude; 113 degrees, 14 minutes, 30 seconds west longitude.

A1—0 to 1 inch; light brown (7.5YR 6/4) very gravelly loam; strong brown (7.5YR 4/6) moist; strong medium platy structure; slightly hard, very friable, nonsticky and moderately plastic; few very fine and fine roots; many very fine and fine and common medium irregular pores; 50 percent gravel; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

A2—1 to 3 inches; light brown (7.5YR 6/4) very gravelly loam; strong brown (7.5YR 4/6) moist; strong fine platy structure; slightly hard, very friable, slightly sticky and moderately plastic; common very fine and fine and few medium roots; many very fine and fine and few medium irregular pores; 40 percent gravel; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bw—3 to 5 inches; light brown (7.5YR 6/4) very gravelly loam; strong brown (7.5YR 4/6) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and moderately plastic; many very fine and fine and few medium roots; few fine and medium tubular pores; 50 percent gravel; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bkm—5 to 20 inches; indurated petrocalcic with laminar cap.

Bk—20 to 60 inches; light brown (7.5YR 6/4) very gravelly loam; strong brown (7.5YR 4/6) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and moderately plastic; few fine and medium tubular pores; 50 percent gravel; many thick calcium carbonate coats and pendants on the underside of rock fragments; violently effervescent; moderately alkaline (pH 7.4).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Haplogypsid soils

Taxonomic classification: Haplogypsid

Geomorphic position: gypsiferous beds of the Hermit Formation

Parent material: residuum weathered from sandstone and siltstone

Slope: 8 to 15 percent

Depth to restrictive feature: 10 to 50 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Mudstone Hills, Gypsiferous 6-10" p.z.

Ecosystem site number: 035XE503AZ

Present native vegetation: shadscale saltbush, anderson wolfberry, Torrey Mormon tea, Opuntia, catclaw acacia

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Esplanade; 1.08 miles south of Keyhole Dam; 36 degrees, 11 minutes, 31 second north latitude; 113 degrees, 16 minutes, 55 seconds west longitude.

A—0 to 2 inches; reddish yellow (5YR 6/6) very fine sandy loam, reddish brown (5YR 4/4) moist; weak fine subangular blocky structure parting to weak coarse granular, 20 percent areas with weak coarse platy structure; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; common very fine irregular and few fine tubular pores; 5 percent siltstone channers; 5 percent crystalline gypsum; violently effervescent; moderately alkaline (pH 8.0); abrupt wavy boundary.

Cy1—2 to 5 inches; yellowish red (5YR 5/6) channery very fine sandy loam; yellowish red (5YR 4/6) moist; the apparent dry texture is gravelly loamy coarse sand; massive; soft, very friable, nonsticky and nonplastic; common very fine roots, common very fine and fine irregular pores; 25 percent siltstone and sandstone channers; 30 percent crystalline gypsum; 40 percent discontinuous and irregular plates of crystalline gypsum (5YR 8/3); violently effervescent; slightly alkaline (pH 7.8); abrupt smooth boundary.

Cy2—5 to 10 inches; light reddish brown (5YR 6/4) channery very fine sandy loam; reddish brown (5YR 5/4) moist; the apparent dry texture is channery loamy

coarse sand; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots, common very fine and fine irregular pores; 20 percent siltstone channers which occur within the upper 1 inch of the horizon; 55 percent crystalline gypsum; strongly effervescent; slightly alkaline (pH 7.6); abrupt irregular boundary.

R—10 inches; gypsiferous sandstone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Rock outcrop

Steep escarpments at the edges of plateaus and ridges consisting of soft red mudstone and sandstone of the Hermit Formation

142—Typic Petrocalcids-Rock outcrop complex, Hermit Formation, 2 to 50 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,000 to 4,600 feet (1,219 to 1,403 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 210 to 280 days

Map Unit Composition

Typic Petrocalcids and similar soils: 40 percent

Rock outcrop: 30 percent

Typic Petrocalcids and similar soils: 30 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Typic Petrocalcids soils

Taxonomic classification: Typic Petrocalcids

Geomorphic position: summits of fan terraces and fan terraces on plateau escarpments

Parent material: alluvium derived from limestone and/or colluvium derived from limestone and/or eolian deposits derived from limestone

Slope: 2 to 15 percent

Depth to restrictive feature: 3 to 10 inches to petrocalcic

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Upland, Shallow 6-10" p.z.

Ecosystem site number: 035XE519AZ

Present native vegetation: blackbrush, ephedra, Opuntia, banana yucca

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In Whitmore Canyon; 1.27 miles northeast of Paws Pocket; 36 degrees, 12 minutes, 15 seconds north latitude; 113 degrees, 11 minutes, 55 seconds west longitude.

A1—0 to 1 inch; brown (10YR 5/3) extremely gravelly loam; dark brown (10YR 3/3) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine and common medium roots; many very fine tubular pores; 50 percent gravel, 10 percent cobble, and 5 percent stone; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

A2—1 to 3 inches; brown (10YR 5/4) very gravelly loam; brown (10YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine and common medium roots; many very fine and fine tubular pores; 40 percent gravel, 5 percent cobble; violently effervescent; moderately alkaline (pH 8.4); abrupt wavy boundary.

Bkm—3 to 24 inches; pinkish gray (10YR 7/2) very gravelly calcium carbonate cemented lenses with indurated laminar cap; extremely hard; clear wavy boundary.

Bk—24 to 60 inches; pinkish gray (10YR 7/2) very

gravelly sandy loam; light brown (10YR 6/3) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; few fine and medium roots; few fine tubular pores; 50 percent gravel; violently effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Typic Petrocalcids soils

Taxonomic classification: Typic Petrocalcids

Geomorphic position: shoulders and sideslopes of fan terraces and fan terraces on plateau escarpments

Parent material: alluvium derived from limestone and/or colluvium derived from limestone and/or eolian deposits derived from mixed

Slope: 15 to 50 percent

Depth to restrictive feature: 3 to 10 inches to petrocalcic

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Slopes, Shallow 6-10" p.z.

Ecosystem site number: 035XE517AZ

Present native vegetation: blackbrush, ephedra, banana yucca

Land capability (nonirrigated): 7c

Taxonomic Unit Description

A1—0 to 1 inch; brown (10YR 5/3) extremely gravelly loam; dark brown (10YR 3/3) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine and common medium roots; many very fine tubular pores; 50 percent gravel, 10 percent cobble, and 5 percent stone; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

A2—1 to 3 inches; brown (10YR 5/4) very gravelly loam; brown (10YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine and common medium roots; many very fine and fine tubular pores;

40 percent gravel, 5 percent cobble; violently effervescent; moderately alkaline (pH 8.4); abrupt wavy boundary.

Bkm—3 to 24 inches; pinkish gray (10YR 7/2) very gravelly calcium carbonate cemented lenses with indurated laminar cap; extremely hard; clear wavy boundary.

Bk—24 to 60 inches; pinkish gray (10YR 7/2) very gravelly sandy loam; light brown (10YR 6/3) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; few fine and medium roots; few fine tubular pores; 50 percent gravel; violently effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Rock outcrop

Escarpments of plateaus consisting of soft red mudstone of the Hermit Formation

143—Typic Torrifluvents, 0 to 1 percent slopes

Map Unit Setting

Landform: flood plain

Elevation: 1,200 to 1,300 feet (365 to 396 meters)

Mean annual precipitation: 3 to 6 inches (76 to 152 millimeters)

Mean annual air temperature: 72 to 75 degrees F (22 to 24 degrees C)

Mean annual soil temperature: 74 to 77 degrees F (24 to 26 degrees C)

Frost-free period: 300 to 340 days

Map Unit Composition

Typic Torrifluvents and similar soils: 100 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Typic Torrifluvents soils

Taxonomic classification: Typic Torrifluvents
Geomorphic position: flood plains
Parent material: alluvium
Slope: 0 to 1 percent
Flooding hazard: Frequent
Seasonal water table minimum depth: about 0 inches
Major Land Resource Area: 30
Land Resource Unit: 30-1
Ecological site name: Sandy Bottom, Wet 3-6" p.z.
Ecosystem site number: 030XA125AZ
Present native vegetation: seepwillow baccharis, desert broom baccharis, desert-willow, screwbean mesquite, catclaw acacia
Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 988 feet east of Azure Ridge Draw; 36 degrees, 15 minutes, 15 seconds north latitude; 114 degrees, 0 minutes, 10 seconds west longitude.

C1—0 to 2 inches; strong brown (7.5YR 5/6) very fine sandy loam, strong brown (7.5YR 4/6) moist; single grain; loose, slightly sticky and slightly plastic; many very fine and few fine roots; many very fine irregular pores; strongly effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

C2—2 to 5 inches; strong brown (7.5YR 4/6) silty clay loam, brown (7.5YR 4/4) moist; moderate thin platy structure; slightly hard, friable, moderately sticky and moderately plastic; many very fine roots; many very fine tubular pores; strongly effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

C3—5 to 36 inches; reddish yellow (7.5YR 6/6) very fine sand, strong brown (7.5YR 4/6) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine, few fine and medium roots; common very fine irregular pores; common lenses of coarse sand; noneffervescent; moderately alkaline (pH 8.4); clear smooth boundary.

C4—36 to 50 inches; reddish yellow (7.5YR 6/6) loamy very fine sand, strong brown (7.5YR 4/6) moist; massive; hard, firm, nonsticky and nonplastic; few fine and medium roots; many fine tubular pores; strongly effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

C5—50 to 60 inches; strong brown (7.5YR 5/6) loamy very fine sand, brown (7.5YR 4/4) moist; single grain;

loose, nonsticky and nonplastic; few fine roots; common very fine irregular pores; strongly effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

144—Typic Torrifluvents-Typic Torripsamments complex, 0 to 6 percent slopes

Map Unit Setting

Landform: stream terrace
Elevation: 1,600 to 2,500 feet (488 to 762 meters)
Mean annual precipitation: 3 to 6 inches (76 to 152 millimeters)
Mean annual air temperature: 70 to 77 degrees F (21 to 25 degrees C)
Mean annual soil temperature: 72 to 79 degrees F (23 to 27 degrees C)
Frost-free period: 300 to 330 days

Map Unit Composition

Typic Torrifluvents and similar soils: 75 percent
 Typic Torripsamments and similar soils: 15 percent
 Minor components: 10 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Typic Torrifluvents soils

Taxonomic classification: Typic Torrifluvents
Geomorphic position: beaches of sandy terraces along the Colorado River
Parent material: alluvium derived from mixed sources
Slope: 0 to 2 percent
Depth to restrictive feature: greater than 60 inches to bedrock; 2 to 59 inches to strongly contrasting textural stratification

Flooding hazard: Rare

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 30

Land Resource Unit: 30-1

Ecological site name: Sandy Bottom 3-6" p.z.

Ecosystem site number: 030XA112AZ

Present native vegetation: catclaw acacia, screwbean mesquite, desert-willow, creosotebush, white burrobrush

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 192 feet southwest of Granite Park Canyon; 35 degrees, 58 minutes, 5 seconds north latitude; 113 degrees, 18 minutes, 51 seconds west longitude.

A—0 to 4 inches; pale brown (10YR 6/3) silt loam; brown (10YR 4/3) moist; moderate thin platy structure; slightly hard, friable, very sticky and very plastic; many very fine roots; common very fine tubular pores; violently effervescent; moderately alkaline (pH 8.2); abrupt wavy boundary.

C1—4 to 10 inches; light reddish brown (5YR 6/4) very fine sandy loam; yellowish red (5YR 4/6) moist; massive; slightly hard; very friable, nonsticky and nonplastic; many very fine and common fine roots; common fine tubular pores; violently effervescent; moderately alkaline (pH 8.2); abrupt wavy boundary.

C2—10 to 15 inches; very pale brown (10YR 7/3) silty clay; brown (10YR 5/3) moist; strong thick platy structure; very hard, firm, very sticky and very plastic; few fine and medium roots; few fine tubular pores; violently effervescent; moderately alkaline (pH 8.0); abrupt wavy boundary.

C3—15 to 25 inches; light brown (7.5YR 6/4) sand; brown (7.5YR 4/4) moist; single grain; loose; nonsticky and nonplastic; common fine and few medium and coarse roots; many very fine irregular pores; violently effervescent; moderately alkaline (pH 8.2); abrupt wavy boundary.

C4—25 to 36 inches; light reddish brown (5YR 6/4) loam; yellowish red (5YR 4/6) moist; massive slightly hard, very friable, nonsticky and nonplastic; many fine through coarse roots; few very fine tubular pores; violently effervescent; moderately alkaline (pH 8.4); abrupt wavy boundary.

C5—36 to 45 inches; pale brown (10YR 6/3) silty clay loam; dark yellowish brown (10YR 4/4) moist; moderate thick platy structure; hard; friable, moderately sticky

and moderately plastic; common fine through coarse roots; few fine tubular pores; violently effervescent; strongly alkaline (pH 8.6); abrupt wavy boundary.

C6—45 to 61 inches; light reddish brown (5YR 6/4) loamy very fine sand; yellowish red (5YR 4/6) moist; massive; soft, very friable, nonsticky and nonplastic; many fine through coarse roots; few very fine tubular pores; violently effervescent; moderately alkaline (pH 8.2); abrupt wavy boundary.

C7—61 to 72 inches; pale brown (10YR 6/3) silt; brown (10YR 4/3) moist; massive, slightly hard, friable, very sticky and very plastic; many very fine through coarse roots; common fine tubular pores; violently effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Typic Torripsamments soils

Taxonomic classification: Typic Torripsamments

Geomorphic position: dunes of well-sorted fine sand

Parent material: beach sand derived from mixed sources and/or eolian sands derived from mixed sources

Slope: 2 to 6 percent

Depth to restrictive feature: greater than 60 inches to bedrock

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 30

Land Resource Unit: 30-1

Ecological site name: Sandy Upland 3-6" p.z.

Ecosystem site number: 030XA113AZ

Present native vegetation: big galleta, Nevada Mormon tea, creosotebush, white bursage, white ratany

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 4,183 feet north of The Tower of Ra; 36 degrees, 9 minutes, 7 seconds north latitude; 112 degrees, 11 minutes, 58 seconds west longitude.

A—0 to 1 inch; pale brown (10YR 6/3) fine sand; brown

(10YR 4/3) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine roots; many very fine and few fine irregular pores; noneffervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

C1—1 to 40 inches; pale brown (10YR 6/3) fine sand; brown (10YR 4/3) moist; single grain; loose; nonsticky and nonplastic; many very fine and few fine through coarse roots; many very fine and fine irregular pores; noneffervescent; moderately alkaline (pH 8.0); gradual irregular boundary.

C2—40 to 60 inches; pale brown (10YR 6/3) extremely stony fine sand; brown (10YR 4/3) moist; single grain; loose; nonsticky and nonplastic; few fine through medium roots; many very fine and fine irregular pores; 10 percent gravel, 10 percent cobble, and 40 percent stone; noneffervescent; moderately alkaline (pH 8.0).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

145—Typic Torrifluvents-Typic Torripsamments complex, cool, 0 to 6 percent slopes

Map Unit Setting

Landform: stream terrace

Elevation: 2,500 to 3,500 feet (762 to 1,067 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 210 to 280 days

Map Unit Composition

Typic Torrifluvents and similar soils: 70 percent

Typic Torripsamments and similar soils: 30 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major

components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Typic Torrifluvents soils

Taxonomic classification: Typic Torrifluvents

Geomorphic position: beaches and stream terraces

Parent material: alluvium derived from mixed sources

Slope: 0 to 2 percent

Depth to restrictive feature: 20 to 60 inches to bedrock (lithic)

Flooding hazard: Rare

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Sandy Wash 6-10" p.z.

Ecosystem site number: 035XE511AZ

Present native vegetation: Sporobolus, Apache plume, longleaf brickellbush, alkali jimmyweed, cane beardgrass

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 36 degrees, 18 minutes, 30 seconds north latitude; 111 degrees, 51 minutes, 55 seconds west longitude.

A—0 to 6 inches; brown (7.5YR 5/4) loamy fine sand; brown (7.5YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; common fine irregular pores; violently effervescent; strongly alkaline (pH 8.6); clear smooth boundary.

C1—6 to 20 inches; brown (7.5YR 5/4) silt loam; brown (7.5YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine and few medium roots; common fine irregular pores; 5 percent gravel, 5 percent cobble; violently effervescent; strongly alkaline (pH 8.8); gradual wavy boundary.

C2—20 to 40 inches; brown (7.5YR 5/4) sandy loam; brown (7.5YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; common fine and medium roots; common fine irregular pores; 5 percent gravel, 5 percent cobble; violently effervescent; strongly alkaline (pH 8.8); gradual wavy boundary.

C3—40 to 60 inches; brown (7.5YR 5/4) sandy loam; brown (7.5YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; few fine and medium roots; common fine irregular pores; 5 percent gravel, 5

percent cobble; violently effervescent; strongly alkaline (pH 8.8).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Typic Torripsamments soils

Taxonomic classification: Typic Torripsamments

Geomorphic position: dunes

Parent material: sandy eolian deposits

Slope: 2 to 6 percent

Depth to restrictive feature: 20 to 60 inches to bedrock (lithic)

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Sandy Upland 6-10" p.z.

Ecosystem site number: 035XE515AZ

Present native vegetation: Sporobolus, Indian ricegrass, Opuntia, fourwing saltbush, soaptree yucca

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the interior of the Grand Canyon; 36 degrees, 22 minutes, 25 seconds north latitude; 112 degrees, 28 minutes, 14 seconds west longitude.

A—0 to 2 inches; pale brown (10YR 6/3) loamy fine sand; yellowish brown (10YR 5/4) moist; weak thin platy structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine irregular pores; noneffervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

C1—2 to 35 inches; pale brown (10YR 6/3) fine sand; yellowish brown (10YR 5/4) moist; single grain; loose, nonsticky and nonplastic; many very fine and fine roots; many very fine irregular pores; 5 percent gravel; noneffervescent; moderately alkaline (pH 8.0); gradual wavy boundary.

C2—35 to 60 inches; pale brown (10YR 6/3) stony fine sand; yellowish brown (10YR 5/4) moist; single grain; loose, nonsticky and nonplastic; few fine roots; many

very fine irregular pores; 15 percent cobble, 15 percent stone; noneffervescent; moderately alkaline (pH 8.2).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

146—Typic Torriorthents soils and Badlands, Chuar Group, 15 to 65 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,500 to 4,500 feet (1,067 to 1,372 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 200 to 240 days

Map Unit Composition

Typic Torriorthents and similar soils: 60 percent
Badlands: 40 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Typic Torriorthents soils

Taxonomic classification: Typic Torriorthents

Geomorphic position: summits and sideslopes of hills and ridges

Parent material: residuum weathered from mudstone

Slope: 15 to 65 percent

Depth to restrictive feature: 10 to 60 inches to bedrock (paralithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Mudstone Hills, Gypsiferous
6-10" p.z.

Ecosystem site number: 035XE503AZ

Present native vegetation: shadscale saltbush,
anderson wolfberry, Torrey Mormon tea, Opuntia,
catclaw acacia

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In Chuar Valley; 1,570 feet west of Chuar Lava Hill; 36 degrees, 8 minutes, 40 seconds north latitude; 111 degrees, 49 minutes, 50 seconds west longitude.

C—0 to 10 inches; light reddish brown (2.5YR 6/3) silty clay; reddish brown (2.5YR 5/4) moist; massive; hard, firm, very sticky and very plastic; few fine roots; common fine irregular pores; 5 percent gravel; violently effervescent; strongly alkaline (pH 8.8); abrupt irregular boundary.

Cr—10 to 60 inches; soft, weathered mudstone.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Badlands

Summits and sideslopes of hills and ridges

147—Typic Torriorthents, 2 to 8 percent slopes

Map Unit Setting

Landform: valley floor

Elevation: 1,500 to 2,000 feet (457 to 610 meters)

Mean annual precipitation: 6 to 9 inches

C3—28 to 38 inches; pale brown (10YR 6/3) sand, yellowish brown (10YR 5/4) moist; single grain; loose, nonsticky and nonplastic; common very fine and fine roots; few very fine tubular pores; 10 percent gravel; slightly effervescent; strongly alkaline (pH 8.6); clear smooth boundary.

C4—38 to 60 inches; pink (7.5YR 7/3) sandy loam, brown (7.5YR 5/4) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; few very fine tubular pores; 5 percent gravel; slightly effervescent; strongly alkaline (pH 8.6).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

148—Typic Torriorthents-Typic Haplogypsis complex, Hermit Formation, 15 to 40 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,500 to 5,000 feet (1,372 to 1,524 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 55 to 57 degrees F (13 to 14 degrees C)

Mean annual soil temperature: 57 to 59 degrees F (15 to 16 degrees C)

Frost-free period: 180 to 195 days

Map Unit Composition

Typic Torriorthents and similar soils: 60 percent
Typic Haplogypsis and similar soils: 40 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Typic Torriorthents soils

Taxonomic classification: Typic Torriorthents

Geomorphic position: very steep hills and ridges

Parent material: alluvium derived from siltstone and/or alluvium derived from sandstone and shale and/or residuum weathered from siltstone and/or residuum weathered from sandstone and shale

Slope: 15 to 40 percent

Depth to restrictive feature: 20 to 60 inches to bedrock (paralithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Mudstone Hills, Gypsiferous 6-10" p.z.

Ecosystem site number: 035XE503AZ

Present native vegetation: shadscale saltbush, anderson wolfberry, Torrey Mormon tea, Opuntia, catclaw acacia

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Point data was not available for this map unit. Data was aggregated from map unit 155, which is similar but thermic

C—0 to 4 inches; yellowish red (5YR 5/6) very gravelly sandy loam; yellowish red (5YR 4/6) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; common very fine and fine irregular pores; 60 percent gypsum; 50 percent gravel; strongly effervescent; moderately alkaline (pH 8.0); abrupt irregular boundary.

Cr—4 to 60 inches; gypsiferous siltstone and shale.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Typic Haplogypsis soils

Taxonomic classification: Typic Haplogypsis

Geomorphic position: very steep hills and ridges

Parent material: alluvium derived from siltstone and/or alluvium derived from sandstone and shale and/or residuum weathered from siltstone and/or residuum weathered from sandstone and shale

Slope: 15 to 40 percent

Depth to restrictive feature: 20 to 60 inches to bedrock (paralithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Mudstone Hills, Gypsiferous 6-10" p.z.

Ecosystem site number: 035XE503AZ

Present native vegetation: shadscale saltbush, anderson wolfberry, Torrey Mormon tea, Opuntia, catclaw acacia

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Point data was not available for this map unit. Data was aggregated from map unit 155, which is similar but thermic.

A—0 to 1 inch; light brown (7.5YR 6/4) extremely gravelly fine sandy loam; brown (7.5YR 5/4) moist; moderate thin platy structure; soft, very friable, nonsticky and nonplastic; few very fine roots; common very fine and fine irregular pores; 70 percent gravel; strongly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

By—1 to 8 inches; light brown (7.5YR 6/4) sandy loam; brown (7.5YR 5/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine roots; common very fine irregular pores; many fine gypsum crystals; 10 percent gravel; strongly effervescent; moderately alkaline (pH 8.0); abrupt wavy boundary.

Cy—8 to 23 inches; variegated (7.5YR 6/3 and 5YR 7/2) very gravelly loamy sand; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; common very fine irregular pores; many fine and medium gypsum plates and crystals; 40 percent gravel; strongly effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

R—23 inches; gypsiferous siltstone and shale.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

149—Ustic Haplargids-Lava Flows complex, 2 to 20 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,700 to 5,100 feet (1,433 to 1,554 meters)

Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)

Mean annual air temperature: 55 to 57 degrees F (12 to 14 degrees C)

Mean annual soil temperature: 57 to 59 degrees F (14 to 15 degrees C)

Frost-free period: 145 to 150 days

Map Unit Composition

Ustic Haplargids and similar soils: 70 percent

Lava Flows: 30 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Ustic Haplargids soils

Taxonomic classification: Ustic Haplargids

Geomorphic position: depressions between pressure ridges of basalt flows

Parent material: residuum weathered from basalt

Slope: 2 to 20 percent

Depth to restrictive feature: 25 to 40 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Basalt Upland 10-14" p.z.

Ecosystem site number: 035XC301AZ

Present native vegetation: Wyoming big sagebrush, blue grama, Colorado pinyon, Utah juniper, black grama, fourwing saltbush

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Esplanade; 997 feet southwest of Sage Flat Reservoir; 36 degrees, 12 minutes, 5 seconds north latitude; 113 degrees, 10 minutes, 10 seconds west longitude.

A—0 to 2 inches; yellowish brown (10YR 5/4) very gravelly loam; dark yellowish brown (10YR 3/4) moist;

weak fine platy structure; slightly hard, friable, moderately sticky and slightly plastic; few very fine roots; many very fine vesicular pores; noneffervescent; 40 percent gravel, 10 percent cobble; neutral (pH 7.0); abrupt smooth boundary.

Bt1—2 to 7 inches; brown (7.5YR 4/4) cobbly clay loam; dark brown (7.5YR 3/4) moist; strong fine subangular blocky structure; hard, friable, moderately sticky and moderately plastic; common very fine through medium roots; many very fine through medium tubular pores; common faint clay films lining pores; noneffervescent; 5 percent gravel, 15 percent cobble; neutral (pH 7.2); clear smooth boundary.

Bt2—7 to 14 inches; brown (7.5YR 4/4) cobbly clay loam; dark brown (7.5YR 3/4) moist; strong fine subangular blocky structure; hard, friable, moderately sticky and moderately plastic; common fine through coarse roots; many very fine through coarse tubular pores; many distinct clay films on faces of peds; noneffervescent; 5 percent gravel, 10 percent cobble; slightly alkaline (pH 7.4); clear smooth boundary.

Btk—14 to 29 inches; brown (7.5YR 5/4) clay loam; brown (7.5YR 4/4) moist; weak coarse subangular blocky structure; hard, firm, moderately sticky and moderately plastic; few fine and medium roots; many very fine and fine tubular pores; many distinct clay films on faces of peds; few fine calcium carbonate filaments; strongly effervescent; 5 percent gravel, 5 percent cobble; moderately alkaline (pH 8.0); abrupt irregular boundary.

R—29 inches; basalt bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Lava Flows

Pressure ridges and push ups of basalt flows

150—Ustic Haplocalcids-Ustic Petrocalcids complex, 2 to 4 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,500 to 5,000 feet (1,372 to 1,524 meters)

Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)

Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)

Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)

Frost-free period: 145 to 160 days

Map Unit Composition

Ustic Haplocalcids and similar soils: 80 percent

Ustic Petrocalcids and similar soils: 20 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Ustic Haplocalcids soils

Taxonomic classification: Ustic Haplocalcids

Geomorphic position: stream terraces and gravel bars of ephemeral drainageways

Parent material: alluvium derived from limestone, sandstone, and shale and/or colluvium derived from limestone, sandstone, and shale

Slope: 2 to 4 percent

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Loamy Upland, Calcareous 10-14" p.z.

Ecosystem site number: 035XC338AZ

Present native vegetation: Wyoming big sagebrush, needleandthread, Nevada Mormon tea, galleta, Indian ricegrass, fourwing saltbush

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Esplanade; 1.26 miles southwest of Toroweap Point; 36 degrees, 15 minutes, 28 seconds north latitude; 113 degrees, 4 minutes, 25 seconds west longitude.

A1—0 to 2 inches; brown (7.5YR 5/4) sandy loam; brown (7.5YR 4/4) moist; moderate fine subangular blocky structure; soft, very friable; slightly sticky and slightly plastic; common very fine and few fine roots; common very fine tubular pores; 10 percent gravel; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

A2—2 to 6 inches; brown (7.5YR 5/4) sandy loam; brown (7.5YR 4/4) moist; moderate fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine and fine roots; common fine tubular pores; 5 percent gravel; violently effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bk1—6 to 18 inches; strong brown (7.5YR 5/6) loam; strong brown (7.5YR 4/6) moist; strong fine subangular blocky structure; slightly hard, very friable, slightly sticky and moderately plastic; common fine and few medium roots; few fine tubular pores; few fine soft masses of calcium carbonate; 5 percent gravel; violently effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

2Bk2—18 to 30 inches; strong brown (7.5YR 5/6) loam; strong brown (7.5YR 4/6) moist; strong fine subangular blocky structure; hard, friable, moderately sticky and moderately plastic; common fine and few medium roots; few fine tubular pores; many fine and medium soft masses of calcium carbonate; 5 percent gravel; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

2Bk3—30 to 60 inches; strong brown (7.5YR 5/6) loam; strong brown (7.5YR 4/6) moist; strong fine subangular blocky structure; very hard, friable, moderately sticky and moderately plastic; common fine and few medium roots; few fine tubular pores; many fine and medium soft masses and concretions of calcium carbonate; violently effervescent; strongly alkaline (pH 8.6).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit

description is representative of what may be found in this landscape position.

Ustic Petrocalcids soils

Taxonomic classification: Ustic Petrocalcids
Geomorphic position: stream terraces and gravel bars of ephemeral drainageways
Parent material: alluvium derived from limestone, sandstone, and shale and/or colluvium derived from limestone, sandstone, and shale
Slope: 2 to 4 percent
Depth to restrictive feature: 20 to 40 inches to petrocalcic
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Major Land Resource Area: 35
Land Resource Unit: 35-3
Ecological site name: Loamy Upland, Calcareous 10-14" p.z.
Ecosystem site number: 035XC338AZ
Present native vegetation: Wyoming big sagebrush, needleandthread, Nevada Mormon tea, galleta, Indian ☐. M

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Bk—16 to 23 inches; light brown (7.5YR 6/4) very gravelly fine sandy loam; brown (7.5YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine through coarse roots; few very fine tubular pores; continuous moderately thick coats of calcium carbonate on rock fragments; 40 percent gravel and pan fragments; violently effervescent; strongly alkaline (pH 8.6); abrupt smooth boundary.

2Bkm—23 inches; indurated petrocalcic horizon.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

151—Ustic Haplocalcids-Ustic Petrocalcids-Rock outcrop complex, Hermit Formation, 8 to 60 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,500 to 5,000 feet (1,372 to 1,524 meters)

Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)

Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)

Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)

Frost-free period: 145 to 160 days

Map Unit Composition

Ustic Haplocalcids and similar soils: 60 percent

Ustic Petrocalcids and similar soils: 25 percent

Rock outcrop: 15 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Ustic Haplocalcids soils

Taxonomic classification: Ustic Haplocalcids

Geomorphic position: summits and sideslopes of fan terraces on colluvial slopes of plateau escarpments

Parent material: alluvium derived from limestone, sandstone, and shale and/or colluvium derived from limestone, sandstone, and shale

Slope: 8 to 60 percent

Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Limy Slopes 10-14" p.z.

Ecosystem site number: 035XC310AZ

Present native vegetation: needleandthread, black grama, fourwing saltbush, Indian ricegrass, Nevada Mormon tea, Stansbury cliffrose

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In Toroweap Valley; 3,649 feet south of Toroweap Ranger Station; 36 degrees, 16 minutes, 35 seconds north latitude; 113 degrees, 3 minutes, 34 seconds west longitude.

A—0 to 2 inches; light reddish brown (5YR 6/4) extremely cobbly loam; yellowish red (5YR 4/6) moist; moderate fine subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common very fine roots; common very fine irregular pores; 30 percent gravel, 20 percent cobble, and 15 percent stone; strongly effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

Bk1—2 to 7 inches; light reddish brown (5YR 6/4) extremely cobbly loam; yellowish red (5YR 4/6) moist; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine tubular pores; many soft masses of calcium carbonate; 20 percent gravel, 25 percent cobble, and 15 percent stone; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

Bk2—7 to 14 inches; light reddish brown (5YR 6/4) extremely cobbly loam; yellowish red (5YR 4/6) moist; strong coarse and medium angular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine and few fine roots; common very fine and fine tubular pores; many very fine and fine calcium carbonate seams and coatings lining pores and on faces of peds; moderately to strongly cemented by calcium carbonate with a thin laminar cap; 25 percent gravel, 25 percent cobble, and 10 percent stone;

violently effervescent; moderately alkaline (pH 8.4); clear irregular boundary.

Bk3—14 to 26 inches; light reddish brown (5YR 4/6) very cobbly loam; yellowish red (5YR 4/6) moist; strong coarse and medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few very fine roots; common very fine and fine tubular pores; many very fine and fine calcium carbonate seams and coatings lining pores and on faces of peds; strongly cemented by calcium carbonate; 20 percent gravel, 25 percent cobble, and 10 percent stone; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

R—26 inches; sandstone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Ustic Petrocalcids soils

Taxonomic classification: Ustic Petrocalcids

Geomorphic position: summits of fan terraces on colluvial side slopes of plateau escarpments

Parent material: alluvium derived from limestone, sandstone, and shale and/or colluvium derived from limestone, sandstone, and shale

Slope: 8 to 60 percent

Depth to restrictive feature: 7 to 20 inches to petrocalcic

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Limy Slopes 10-14" p.z.

Ecosystem site number: 035XC310AZ

Present native vegetation: needleandthread, black grama, fourwing saltbush, Indian ricegrass, Nevada Mormon tea, Stansbury cliffrose

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Esplanade; 1.08 miles east of Toroweap Point; 36 degrees, 15 minutes, 3 seconds north latitude; 113 degrees, 2 minutes, 10 seconds west longitude.

A—0 to 2 inches; yellowish brown (10YR 5/4) very gravelly loam; dark yellowish brown (10YR 4/4) moist; moderate fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; common very fine irregular pores; 40 percent gravel; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bk— 2 to 18 inches; yellowish brown (10YR 5/4) very gravelly loam; dark yellowish brown (10YR 4/4) moist; moderate fine and medium subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; common very fine and fine roots; common fine tubular pores; common fine soft masses of calcium carbonate; 45 percent gravel; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bkm—18 inches; indurated petrocalcic horizon with a thin laminar cap.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Rock outcrop

Steep pediments on plateau escarpments consisting of the mudstone of the Hermit Formation

152—Ustic Haplocambids, 1 to 2 percent slopes

Map Unit Setting

Landform: fan terrace

Elevation: 4,500 to 5,000 feet (1,372 to 1,524 meters)

Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)

Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)

Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)

Frost-free period: 145 to 160 days

Map Unit Composition

Ustic Haplocambids and similar soils: 100 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor

components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Ustic Haplocambids soils

Taxonomic classification: Ustic Haplocambids

Geomorphic position: fan skirts

Parent material: alluvium derived from limestone, sandstone, and shale and/or alluvium derived from basalt

Slope: 1 to 3 percent

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Loamy Upland 10-14" p.z.

Ecosystem site number: 035XC313AZ

Present native vegetation: Wyoming big sagebrush, blue grama, galleta, Nevada Mormon tea, Opuntia, bottlebrush squirreltail

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In Toroweap Valley; 1.41 miles southwest of Toroweap Ranger Station; 36 degrees, 16 minutes, 30 seconds north latitude; 113 degrees, 5 minutes, 6 seconds west longitude.

A—0 to 4 inches; yellowish brown (10YR 5/4) silt loam; dark yellowish brown (10YR 4/4) moist; moderate thin platy structure parting to strong very fine granular; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine through medium vesicular and few fine tubular pores; 2 percent gravel; violently effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bw1—4 to 16 inches; yellowish brown (10YR 5/4) silt loam; dark yellowish brown (10YR 4/4) moist; moderate fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and fine and few medium and coarse roots; common very fine and fine and few medium tubular pores; few fine soft masses of calcium carbonate; 2 percent gravel; violently effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bw2—15 to 36 inches; yellowish brown (10YR 5/4) loam; dark yellowish brown (10YR 4/4) moist; strong fine and medium subangular blocky structure; hard, very friable, slightly sticky and slightly plastic; common fine and medium and few coarse roots; common very fine and fine tubular pores; common fine

soft seams and masses of calcium carbonate; 32 percent gravel; violently effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Ck—36 to 60 inches; light brown (7.5YR 6/4) loam; brown (7.5YR 5/4) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; few coarse roots; few fine tubular pores; many coarse soft masses of calcium carbonate; violently effervescent; moderately alkaline (pH 8.2).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

153—Ustic Haplocambids, 2 to 15 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,500 to 5,000 feet (1,372 to 1,524 meters)

Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)

Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)

Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)

Frost-free period: 145 to 160 days

Map Unit Composition

Ustic Haplocambids and similar soils: 100 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Ustic Haplocambids soils

Taxonomic classification: Ustic Haplocambids

Geomorphic position: fan piedmonts

Parent material: alluvium derived from scoria

Slope: 2 to 15 percent

Depth to restrictive feature: 60 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Cinder Upland 10-14" p.z.

Ecosystem site number: 035XC304AZ

Present native vegetation: Wyoming big sagebrush, Opuntia, banana yucca, green Mormon tea

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In Toroweap Valley 1.35 miles west of Tuweep Airport; 36 degrees, 17 minutes, 47 seconds north latitude; 113 degrees, 5 minutes, 33 seconds west longitude.

A1—0 to 2 inches; yellowish brown (10YR 5/4) very gravelly sandy loam; dark yellowish brown (10YR 3/4) moist; weak thin platy structure; soft, very friable, nonsticky and nonplastic; few very fine roots; many very fine vesicular pores; 38 percent gravel; noneffervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

A2—2 to 4 inches; yellowish brown (10YR 5/4) gravelly loam; dark yellowish brown (10YR 3/4) moist; weak fine subangular bliv M^{'''}

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b2—2 to 4 inches; yellowish brown (9; avelly

Land Resource Unit: 35-3

Ecological site name: Gypsum Hills 10-14" p.z.

Ecosystem site number: 035XC342AZ

Present native vegetation: ephedra, Bigelow

sagebrush, Fredonia buckwheat, rubber

rabbitbrush, gyp dropseed

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In Chuar Valley; 1,570 feet west of Chuar Lava Hill; 36 degrees, 8 minutes, 40 seconds north latitude; 111 degrees, 49 minutes, 50 seconds west longitude.

C—0 to 10 inches; light reddish brown (2.5YR 6/3) silty clay; reddish brown (2.5YR 5/4) moist; massive; hard, firm, very sticky and very plastic; few fine roots;

10 inches-M M M M i ;); tur4ys9

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

156—Ustic Torriorthents, 2 to 4 percent slopes

Map Unit Setting

Landform: stream terrace

Elevation: 4,500 to 5,000 feet (1,372 to 1,524 meters)

Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)

Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)

Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)

Frost-free period: 145 to 160 days

Map Unit Composition

Ustic Torriorthents and similar soils: 100 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Ustic Torriorthents soils

Taxonomic classification: Ustic Torriorthents

Geomorphic position: stream terraces in ephemeral drainageways

Parent material: alluvium derived from limestone, sandstone, and shale

Slope: 2 to 4 percent

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Loamy Upland 10-14" p.z.

Ecosystem site number: 035XC313AZ

Present native vegetation: Wyoming big sagebrush, blue grama, galleta, Nevada Mormon tea, Opuntia, bottlebrush squirreltail

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In Toroweap Valley; 3,818 feet southwest of Tuweep Airport; 36 degrees, 17 minutes, 44 seconds north latitude; 113 degrees, 4 minutes, 49 seconds west longitude.

A—0 to 4 inches; brown (7.5YR 5/4) silt loam; dark brown (7.5YR 3/4) moist; weak fine subangular blocky structure; slightly hard; very friable, slightly sticky and nonplastic; common very fine through medium roots; common fine irregular and tubular pores; violently effervescent, moderately alkaline (pH 8.2); clear smooth boundary.

Bw1—4 to 12 inches; brown (7.5YR 5/4) loam; dark brown (7.5YR 3/4) moist; moderate medium subangular blocky structure; slightly hard; very friable, slightly sticky and nonplastic; common very fine through medium roots; common fine irregular and tubular pores; violently effervescent, moderately alkaline (pH 8.2); clear smooth boundary.

Bw2—12 to 35 inches; yellowish brown (10YR 5/4) loam; dark yellowish brown (10YR 3/4) moist; weak fine subangular blocky structure; slightly hard; very friable, slightly sticky and nonplastic; common very fine through medium roots; common fine irregular and tubular pores; violently effervescent, moderately alkaline (pH 8.2); gradual smooth boundary.

C1—35 to 40 inches; yellowish brown (10YR 5/4) gravelly loam; dark yellowish brown (10YR 3/4) moist; massive; slightly hard; very friable, slightly sticky and nonplastic; common very fine through medium roots; common fine irregular and tubular pores; few fine soft masses of calcium carbonate; violently effervescent, moderately alkaline (pH 8.2); gradual smooth boundary.

C2—40 to 60 inches; yellowish brown (10YR 5/4) loam; dark yellowish brown (10YR 3/4) moist; massive; slightly hard; very friable, slightly sticky and nonplastic; common very fine through medium roots; common fine irregular and tubular pores; violently effervescent, moderately alkaline (pH 8.2).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

157—Ustic Torriorthents, 4 to 15 percent slopes

Map Unit Setting

Landform: valley floor

Elevation: 4,500 to 5,000 feet (1,372 to 1,524 meters)

Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)

Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)

Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)

Frost-free period: 145 to 160 days

Map Unit Composition

Ustic Torriorthents and similar soils: 100 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Ustic Torriorthents soils

Taxonomic classification: Ustic Torriorthents

Geomorphic position: fan piedmonts

Parent material: alluvium derived from limestone, sandstone, and shale and/or colluvium derived from limestone, sandstone, and shale

Slope: 4 to 15 percent

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Sandy Loam Upland, Calcareous 10-14" p.z.

Ecosystem site number: 035XC334AZ

Present native vegetation: needleandthread, Indian ricegrass, Nevada Mormon tea, blue grama, Wyoming big sagebrush, fourwing saltbush

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In Toroweap Valley; 5,158 feet south of Toroweap Ranger Station; 36 degrees, 16 minutes, 18 seconds north latitude; 113 degrees, 3 minutes, 47 seconds west longitude.

A—0 to 3 inches; brown (7.5YR 5/4) very gravelly sandy loam; brown (7.5YR 4/4) moist; weak thin platy structure parting to weak fine subangular blocky; soft, very friable, nonsticky and nonplastic; common very

fine and fine roots; common very fine tubular and few very fine vesicular pores; 30 percent gravel, 10 percent cobble; strongly effervescent; moderately alkaline (pH 8.2); clear wavy boundary.

C1—3 to 32 inches; light brown (7.5YR 6/4) very cobbly sandy loam; brown (7.5YR 4/4) moist; weak very fine and fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and few fine roots; common very fine and few fine tubular pores; 20 percent gravel, 30 percent cobble; strongly effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

C2—32 to 43 inches; light brown (7.5YR 6/4) very gravelly sandy loam; brown (7.5YR 4/4) moist; weak very fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; few very fine tubular pores; 40 percent gravel, 5 percent cobble; strongly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

C3—43 to 60 inches; light brown (7.5YR 6/4) sandy loam; brown (7.5YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; few very fine tubular pores; 10 percent gravel; strongly effervescent; moderately alkaline (pH 8.0).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

158—Ustic Torriorthents-Lithic Ustic Torriorthents-Lithic Ustic Haplargids complex, Tonto Group and Redwall Formation, 8 to 60 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,000 to 6,000 feet (1,524 to 1,829 meters)

Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)

Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)

Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)

Frost-free period: 145 to 160 days

Map Unit Composition

Ustic Torriorthents and similar soils: 40 percent
 Lithic Ustic Torriorthents and similar soils: 35 percent
 Lithic Ustic Haplargids and similar soils: 25 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Ustic Torriorthents soils

Taxonomic classification: Ustic Torriorthents
Geomorphic position: colluvial slopes on canyon sidewalls
Parent material: colluvium derived from limestone, sandstone, and shale
Slope: 15 to 60 percent
Depth to restrictive feature: 20 to 60 inches to bedrock (lithic)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Major Land Resource Area: 35
Land Resource Unit: 35-3
Ecological site name: Sedimentary Cliffs 10-14" p.z.
Ecosystem site number: 035XC302AZ
Present native vegetation: other evergreen trees, pointleaf manzanita, turbinella oak, Wyoming big sagebrush, skunkbush sumac, spiny greasebush
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In Bright Angel Canyon; 2,707 feet north of The Transept; 36 degrees, 11 minutes, 2 seconds north latitude; 112 degrees, 2 minutes, 42 seconds west longitude.

A—0 to 2 inches; brown (7.5YR 5/4) extremely bouldery sandy clay; brown (7.5YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; common fine tubular pores; 25 percent cobble, 20 percent stone, and 20 percent boulder; strongly effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bk—2 to 18 inches; light brown (7.5YR 6/4) extremely bouldery sandy clay; brown (7.5YR 5/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and medium roots; few fine tubular pores; 20 percent cobble, 20 percent stone, and 30 percent boulder; violently

effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

C—18 to 60 inches; brown (7.5YR 5/4) extremely bouldery sandy clay; massive; soft, very friable, nonsticky and nonplastic; few fine and medium roots; few fine tubular pores; 20 percent channers, 20 percent stone, and 30 percent boulder; violently effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Lithic Ustic Torriorthents soils

Taxonomic classification: Lithic Ustic Torriorthents
Geomorphic position: pockets and ledges of canyon sidewalls on plateau escarpments
Parent material: colluvium derived from limestone, sandstone, and shale
Slope: 15 to 60 percent
Depth to restrictive feature: 5 to 20 inches to bedrock (lithic)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Major Land Resource Area: 35
Land Resource Unit: 35-3
Ecological site name: Sedimentary Cliffs 10-14" p.z.
Ecosystem site number: 035XC302AZ
Present native vegetation: other evergreen trees, pointleaf manzanita, turbinella oak, Wyoming big sagebrush, skunkbush sumac, spiny greasebush
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In Bright Angel Canyon; 2,741 feet south of Bright Angel Point; 36 degrees, 11 minutes, 8 seconds north latitude; 112 degrees, 2 minutes, 56 seconds west longitude.

A—0 to 2 inches; reddish brown (2.5YR 5/4) extremely gravelly sandy loam; reddish brown (2.5YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine roots; few fine tubular pores; 50 percent gravel, 10 percent cobble; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

C—2 to 6 inches; light red (2.5YR 6/6) very gravelly sandy loam; red (2.5YR 5/6) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine roots, few fine tubular pores; 40 percent gravel, 5 percent cobble; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

R—6 inches; limestone bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Lithic Ustic Haplargids soils

Taxonomic classification: Lithic Ustic Haplargids

Geomorphic position: summits and sideslopes of pediments

Parent material: residuum weathered from arkose

Slope: 8 to 15 percent

Depth to restrictive feature: 6 to 20 inches to bedrock (lithic)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Sedimentary Cliffs 10-14" p.z.

Ecosystem site number: 035XC302AZ

Present native vegetation: other evergreen trees, pointleaf manzanita, turbinella oak, Wyoming big sagebrush, skunkbush sumac, spiny greasewood

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In Bright Angel Canyon; 1,152 feet east of The Transept; 36 degrees, 10 minutes, 35 seconds north latitude; 112 degrees, 2 minutes, 20 seconds west longitude.

A—0 to 2 inches; light yellowish brown (2.5Y 6/3) very channery sandy loam; olive brown (2.5Y 4/3) moist; moderate thin platy structure; soft, very friable, nonsticky and nonplastic; common fine and medium roots, many very fine and fine tubular pores; 10 percent gravel, 30 percent channers; noneffervescent; moderately alkaline (pH 8.0); clear smooth boundary.

Bt—2 to 8 inches; brown (7.5YR 4/4) very gravelly clay

loam; dark brown (7.5YR 3/4) moist; moderate fine subangular blocky structure; hard, firm, very sticky and very plastic; common fine and medium roots; common fine and medium tubular pores; common faint clay films on the faces of peds; 40 percent gravel; noneffervescent; moderately alkaline (pH 8.0); clear smooth boundary.

Bt/C—8 to 12 inches; light yellowish brown (2.5Y 6/3) very gravelly clay loam; olive brown (2.5Y 4/3) moist; moderate fine subangular blocky structure; hard, friable, very sticky and very plastic; common fine and medium roots; common fine and medium tubular pores; common distinct brown (7.5YR 5/4) clay films lining pores and on faces of peds; 40 percent gravel; noneffervescent; moderately alkaline (pH 8.0); abrupt irregular boundary.

R—12 inches; hard shale bedrock.

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

159—Valleycity-Berzatic-Seeg families complex, 8 to 60 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,500 to 5,000 feet (1,372 to 1,525 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 55 to 57 degrees F (13 to 14 degrees C)

Mean annual soil temperature: 57 to 59 degrees F (15 to 16 degrees C)

Frost-free period: 180 to 190 days

Map Unit Composition

Valleycity family and similar soils: 40 percent

Berzatic family and similar soils: 35 percent

Seeg family and similar soils: 20 percent

Minor components: 5 percent

- Soils that have petrocalcic horizons
- Soils in drainageways subject to occasional flooding
- Talus slopes devoid of vegetation

- Rock outcrop

Properties and Qualities

Valleycity family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Haplargids
Geomorphic position: steep pediments of plateau escarpments
Parent material: residuum weathered from sandstone and shale
Slope: 8 to 15 percent
Surface fragments: about 60 percent channers, about 5 percent cobbles
Depth to restrictive feature: 6 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Permeability: about 0.13 in/hr (slow)
Available water capacity total inches: 0.7
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: High
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-5
Ecological site name: Limy Slopes, Shallow 6-10" p.z.
Ecosystem site number: 035XE517AZ
Present native vegetation: blackbrush, ephedra, banana yucca
Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In Bright Angel Canyon; 1,872 feet east of Ribbon Falls; 36 degrees, 9 minutes, 27 seconds north latitude; 112 degrees, 2 minutes, 55 seconds west longitude.

A—0 to 1 inch; yellowish brown (10YR 5/4) very channery coarse sandy loam; brown (10YR 4/3) moist; moderate fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; common very fine tubular pores; 55 percent channers; noneffervescent, moderately alkaline (pH 8.0); abrupt smooth boundary.

Bt—1 to 5 inches; yellowish red (5YR 4/6) very channery sandy clay loam; yellowish red (5YR 4/6) moist; strong fine subangular blocky structure; slightly hard, firm, very sticky and very plastic; common very fine and fine roots; few fine tubular pores; common faint clay films lining pores and on faces of peds; 50 percent channers; noneffervescent; moderately alkaline (pH 8.0); abrupt irregular boundary.

Cr—5 to 9 inches; extremely channery sandy clay loam dominated by weathered shale channers.

R—9 inches, shale bedrock.

Range in Characteristics

Depth to bedrock: 6 to 20 inches
 Clay content: 25 to 35 percent in the particle size control section
 Rock fragments: 35 to 70 percent in the particle size control section

A horizon

Hue: 7.5YR, 10YR
 Value: 5 or 6 dry, 4 or 5 moist
 Chroma: 3 or 4, dry or moist

Bt horizon

Hue: 7.5YR, 10YR
 Value: 5 or 6 dry, 4 or 5 moist
 Chroma: 4 through 6, dry or moist

Berzatic family soils

Taxonomic classification: Loamy-skeletal, mixed, calcareous, mesic Lithic Torriorthents
Geomorphic position: pockets and ledges on cliffs and escarpments of plateaus
Parent material: colluvium and/or residuum weathered from limestone
Slope: 8 to 60 percent
Surface fragments: about 50 percent coarse gravel, about 10 percent cobbles, about 20 percent stones
Depth to restrictive feature: 5 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Permeability: about 4.00 in/hr (moderately rapid)
Available water capacity total inches: 0.5
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: very high
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-5
Ecological site name: Limy Slopes 6-10" p.z.
Ecosystem site number: 035XE507AZ
Present native vegetation: black grama, desert needlegrass, blackbrush, blue threeawn, ephedra, Opuntia
Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In Bright Angel Canyon; 2,173 feet northeast of Ribbon Falls; 36 degrees, 9 minutes, 20

seconds north latitude; 112 degrees, 2 minutes, 55 seconds west longitude.

A—0 to 2 inches; light yellowish brown (2.5Y 6/4) extremely cobbly sandy loam; light olive brown (2.5Y 5/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine and fine and few medium roots; many very fine and common fine irregular and tubular pores; 35 percent gravel, 20 percent cobble, and 5 percent stone; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

C—2 to 8 inches; pale olive (5Y 6/4) very gravelly sandy loam; olive (5Y 5/4) moist; massive; soft, very friable, nonsticky and nonplastic; common fine through coarse roots; common very fine and fine and few medium tubular pores; 35 percent gravel, 10 percent cobble, and 5 percent stone; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

R—8 inches; Muav limestone bedrock.

Range in Characteristics

Depth to lithic contact: 5 to 20 inches

Rock fragments: 35 to 80 percent in the particle size control section

Clay content: 5 to 15 percent in the particle size control section

Calcium carbonate: 20 to 40 percent

Organic matter content: Less than 1 percent

A and C horizons

Hue: 10YR, 7.5YR, 5YR, 2.5YR

Value: 4 through 6, dry and moist

Chroma: 2 through 6, dry and moist

Seeg family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Typic Haplocalcids

Geomorphic position: fan terraces and alluvial fans on colluvial slopes on canyons and escarpments of plateaus

Parent material: colluvium derived from limestone, sandstone, and shale

Slope: 8 to 60 percent

Surface fragments: about 40 percent coarse gravel, about 15 percent cobbles, about 15 percent stones

Drainage class: Well drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 2.5

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: C

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Slopes, Shallow 6-10" p.z.

Ecosystem site number: 035XE517AZ

Present native vegetation: blackbrush, ephedra, banana yucca

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In Bright Angel Canyon; 2,863 feet northeast of Ribbon Falls; 36 degrees, 9 minutes, 10 seconds north latitude; 112 degrees, 2 minutes, 55 seconds west longitude.

A1—0 to 1 inch; brown (7.5YR 5/4) extremely cobbly sandy loam; brown (7.5YR 4/4) moist; moderate very fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and common medium roots; many very fine tubular pores; 25 percent gravel, 40 percent cobble, and 10 percent stone; slightly effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

A2—1 to 3 inches; light brown (7.5YR 6/4) extremely cobbly sandy loam; brown (7.5YR 5/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine through medium roots; common fine tubular pores; 20 percent gravel, 35 percent cobble, and 10 percent stone; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bk—3 to 15 inches; pink (5YR 7/3) extremely cobbly sandy loam; light reddish brown (5YR 6/3) moist; moderate medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common fine and medium and few coarse roots; few medium tubular pores; common fine soft filaments of calcium carbonate; 30 percent gravel, 35 percent cobble; violently effervescent, moderately alkaline (pH 8.4); gradual wavy boundary.

2C1—15 to 40 inches; red (2.5YR 5/6) extremely bouldery sandy loam; red (2.5YR 5/6) moist; massive; soft, very friable, nonsticky and nonplastic; few fine through coarse roots; few fine tubular pores; 70 percent boulder; violently effervescent; moderately alkaline (pH 8.4); gradual wavy boundary.

2C2—40 to 60 inches; red (2.5YR 5/6) extremely bouldery sandy loam; red (2.5YR 5/6) moist; massive; soft, very friable, nonsticky and nonplastic; few medium and coarse roots; few fine tubular pores; 60 percent boulder; violently effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Rock fragments: More than 35 percent gravel and cobbles in the control section
 Depth to calcic: 6 to 22 inches
 Clay content in control section: 5 to 10 percent

A horizon

Hue: 5YR, 7.5YR
 Value: 5 or 6 dry, 4 or 5 moist
 Chroma: 4 or 6, dry or moist

Bk, Ck, C horizon

Hue: 2.5YR, 5YR, 7.5YR
 Value: 5 through 8 dry, 4 through 7 moist
 Chroma: 4 through 6, dry or moist

160—Vitrandic Haplocalcids, 15 to 40 percent slopes

Map Unit Setting

Landform: plateau
Elevation: 3,700 to 4,000 feet (1,127 to 1,219 meters)
Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)
Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)
Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)
Frost-free period: 200 to 240 days

Map Unit Composition

Vitrandic Haplocalcids and similar soils: 100 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Vitrandic Haplocalcids soils

Taxonomic classification: Vitrandic Haplocalcids
Geomorphic position: side slopes of cinder cones
Parent material: basaltic volcanic ash and/or cinders
Slope: 15 to 40 percent
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Basalt Hills 6-10" p.z.

Ecosystem site number: 035XE501AZ

Present native vegetation: ephedra, catclaw acacia, blue threeawn, rayless brittlebush, Ferocactus

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Esplanade; 2.01 miles northeast of Cane Spring; 36 degrees, 10 minutes, 51 seconds north latitude; 113 degrees, 13 minutes, 34 seconds west longitude.

A—0 to 3 inches; light brown (7.5YR 6/3) extremely gravelly coarse sandy loam; very dark brown (7.5YR 2.5/3) moist; single grain; loose, nonsticky and nonplastic; few very fine roots; common very fine irregular pores; 80 percent gravel; strongly effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bw—3 to 13 inches; pale brown (10YR 6/3) very gravelly sandy loam; dark brown (7.5YR 3/4) moist; massive; soft, very friable, nonsticky and nonplastic; many very fine and common fine and medium roots; few very fine irregular pores; 40 percent gravel-sized cinders; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bk—13 to 19 inches; pinkish white (7.5YR 8/2) extremely gravelly loamy coarse sand, pink (7.5YR 7/4) moist; massive; hard, firm, nonsticky and nonplastic; few fine roots; few fine irregular pores; discontinuous, weakly cemented with calcium carbonate; few strongly calcium carbonate cemented lenses; violently effervescent; 80 percent gravel-sized cinders, 5 percent cobble; strongly alkaline (pH 8.8); abrupt irregular boundary.

2Ck—19 to 60 inches; dark gray (10YR 4/1) cinders, black (10YR 2/1) moist; single grain; loose, nonsticky and nonplastic, few very fine roots; many very fine irregular pores; common thin coats of calcium carbonate on undersides of rock fragments; violently effervescent; moderately alkaline (pH 8.2).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit

description is representative of what may be found in this landscape position.

161—Vitrandic Haplocambids-Vitrandic Haplocalcids complex, 15 to 40 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 4,800 to 5,300 feet (1,463 to 1,615 meters)

Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)

Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)

Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)

Frost-free period: 145 to 150 days

Map Unit Composition

Vitrandic Haplocambids and similar soils: 70 percent

Vitrandic Haplocalcids and similar soils: 30 percent

Because of the extreme inaccessibility of the map unit, only minimum documentation was possible, and minor components could not be statistically validated. Major components were determined by documented site visits or were extrapolated from remote sensing.

Properties and Qualities

Vitrandic Haplocambids soils

Taxonomic classification: Vitrandic Haplocambids

Geomorphic position: side slopes of cinder cones

Parent material: basaltic volcanic ash and/or cinders

Slope: 15 to 40 percent

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Cinder Hills 10-14" p.z.

Ecosystem site number: 035XC303AZ

Present native vegetation: Wyoming big sagebrush, blue grama, galleta, Colorado pinyon, Utah juniper, fourwing saltbush

Land capability (nonirrigated): 8e

Taxonomic Unit Description

Type Location: On the Esplanade; 2,636 feet west of Sage Flat Reservoir; 36 degrees, 12 minutes, 7 seconds north latitude; 113 degrees, 10 minutes, 36 seconds west longitude.

A—0 to 1 inch; yellowish brown (10YR 5/4) extremely

gravelly coarse sandy loam, dark brown (7.5YR 3/3) moist; weak thin platy structure; soft, very friable, nonsticky and nonplastic; few very fine roots, many very fine through medium irregular and few fine tubular pores; 60 percent gravel-sized cinders; noneffervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bw1—1 to 5 inches; yellowish brown (10YR 5/4) very gravelly coarse sandy loam, dark yellowish brown (10YR 3/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine tubular and irregular pores; 50 percent gravel-sized cinders; slightly effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bw2—5 to 15 inches; yellowish brown (10YR 5/4) very gravelly coarse sandy loam, dark yellowish brown (10YR 3/4) moist; moderate medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common very fine and fine roots; few very fine tubular and few very fine and fine irregular pores; few thin to moderately thick calcium carbonate coats occur irregularly on rock fragments; 45 percent gravel-sized cinders; slightly effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

2Ck—15 to 60 inches; dark gray (10YR 4/1) cinders, black (10YR 2/1) moist; single grain; loose, nonsticky and non plastic, few very fine roots; many very fine irregular pores; common thin coats of calcium carbonate on undersides of rock fragments; violently effervescent; moderately alkaline (pH 8.2).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

Vitrandic Haplocalcids soils

Taxonomic classification: Vitrandic Haplocalcids

Geomorphic position: side slopes of cinder cones

Parent material: basaltic volcanic ash and/or cinders

Slope: 15 to 40 percent

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Cinder Hills 10-14" p.z.

Ecosystem site number: 035XC303AZ

Present native vegetation: Wyoming big sagebrush, blue grama, galleta, Colorado pinyon, Utah juniper, fourwing saltbush

Land capability (nonirrigated): 8e

Taxonomic Unit Description

Type Location: On the Esplanade; 3,460 feet west of Saddle Horse Spring; 36 degrees, 13 minutes, 34 seconds north latitude; 113 degrees, 3 minutes, 59 seconds west longitude.

A—0 to 1 inch; light brown (7.5YR 6/3) extremely gravelly loamy coarse sand; brown (7.5YR 3/4) moist; single grain; loose, nonsticky and nonplastic; few very fine roots; common very fine irregular pores; 60 percent gravel-sized cinders; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bw—1 to 12 inches; pale brown (10YR 6/3) very gravelly loamy coarse sand; brown (7.5YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; many very fine and common fine and medium roots; few very fine irregular pores; 40 percent gravel-sized cinders; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bk1—12 to 17 inches; light brownish gray (10YR 6/2) very gravelly loamy coarse sand; brown (7.5YR 4/3) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine to medium roots; common very fine and fine irregular pores; thin calcium carbonate coats on rock fragments; 50 percent gravel-sized cinders; violently effervescent; very strongly alkaline (pH 8.6); abrupt irregular boundary.

Bk2—17 to 23 inches; pinkish white (7.5YR 8/2) extremely gravelly loamy coarse sand, pink (7.5YR 7/4) moist; massive; hard, firm, nonsticky and nonplastic; few fine roots; few fine irregular pores; discontinuous weakly cemented with calcium carbonate; few strongly calcium carbonate cemented lenses; 55 percent gravel-sized cinders, 5 percent cobble; violently effervescent; strongly alkaline (pH 8.8); abrupt irregular boundary.

2Ck—23 to 60 inches; dark gray (10YR 4/1) cinders, black (10YR 2/1) moist; single grain; loose, nonsticky and nonplastic; few very fine roots; many very fine irregular pores; common thin coats of calcium carbonate on undersides of rock fragments; violently effervescent; moderately alkaline (pH 8.2).

Range in Characteristics

Soils in this landscape position are highly variable with respect to depth, texture, color and/or chemical

properties. Because of extremely difficult access, statistically valid data could not be determined. Therefore, physical and chemical properties of specific horizons are not given and interpretations such as erodibility are not determined. The taxonomic unit description is representative of what may be found in this landscape position.

162—Water

Consists of dam-controlled perennial water in the Colorado River and Lake Mead.

163—Wauquie-Houserock families complex, 2 to 65 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,000 to 6,000 feet (1,524 to 1,829 meters)

Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)

Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)

Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)

Frost-free period: 145 to 160 days

Map Unit Composition

Wauquie family and similar soils: 60 percent
Houserock family and similar soils: 25 percent
Minor components: 15 percent

- Soils in drainageways that are occasionally flooded
- Soils that are deep to bedrock
- Soils that have accumulation of calcium carbonate in the profile
- Rock outcrop

Properties and Qualities

Wauquie family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Aridic Haplustalfs

Geomorphic position: side slopes of hills and ridges

Parent material: colluvium derived from calcareous conglomerate

Slope: 15 to 65 percent

Surface fragments: about 25 percent gravel, about 30 percent cobbles, about 10 percent stones

Drainage class: Well drained

Permeability: about 0.40 in/hr (moderately slow)

Available water capacity total inches: 4.8

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: C

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Cobbly Slopes 10-14" p.z.

Ecosystem site number: 035XC328AZ

Present native vegetation: Wyoming big sagebrush, galleta, black grama, needleandthread, Indian ricegrass, other evergreen trees

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the sideslopes of Cedar Mountain; 36 degrees, 3 minutes, 28 seconds north latitude; 111 degrees, 46 minutes, 4 seconds west longitude.

A—0 to 4 inches; light reddish brown (5YR 6/3) extremely stony loam; reddish brown (5YR 4/3) moist; moderate thin platy structure parting to moderate fine subangular blocky; soft, very friable, slightly sticky and slightly plastic; common very fine and fine roots; few very fine vesicular and common very fine tubular pores; 15 percent gravel, 10 percent cobble, and 35 percent stone; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Btk—4 to 30 inches; reddish brown (5YR 5/3) extremely stony loam; reddish brown (5YR 4/3) moist; weak medium and fine subangular blocky structure; slightly hard, friable, slightly sticky and moderately plastic; common very fine and fine and few medium and coarse roots; few very fine and fine tubular pores; many faint clay films bridging sand grains and lining pores; 30 percent gravel, 15 percent cobble, and 30 percent stone; violently effervescent; moderately alkaline (pH 8.4); gradual wavy boundary.

2Btk2—30 to 50 inches; reddish brown (5YR 5/3) cobbly loam; reddish brown (5YR 4/3) moist; moderate medium prismatic structure parting to strong very fine and fine subangular blocky; hard, friable, slightly sticky and moderately plastic; common very fine and fine and few medium and coarse roots; common very fine and few fine tubular pores; many faint clay films on faces of peds and lining pores; 15 percent gravel, 10 percent cobble, and 5 percent stone; strongly effervescent; moderately alkaline (pH 8.2); diffuse wavy boundary.

2Bk—50 to 60 inches; yellowish red (5YR 5/6) gravelly loam; yellowish red (5YR 4/6) moist; moderate medium and fine subangular blocky structure; slightly hard,

friable, slightly sticky and slightly plastic; few very fine and fine roots; common very fine and few fine tubular pores; few very fine soft filaments of calcium carbonate; 20 percent gravel, 5 percent cobble; violently effervescent; moderately alkaline (pH 8.4).

Range in Characteristics

Particle size control section: 15 to 25 percent clay
Depth to the base of the argillic horizon: 12 to 40 inches

A horizon

Hue: 5YR to 10YR

Value: 3 through 6 dry, 2 through 4 moist

Chroma: 2 through 4, dry or moist

Calcium carbonate equivalent: 5 to 15 percent

Btk horizon

Hue: 2.5YR to 10YR

Value: 4 through 6 dry, 3 or 4 moist

Chroma: 2 through 6, dry or moist

Rock fragments: 35 to 85 percent

Calcium carbonate equivalent: 5 to 15 percent

Bk horizon

Hue: 2.5YR to 10YR

Value: 5 through 8 dry 4 through 6 moist

Chroma: 2 through 6, dry or moist

Rock fragments: 35 to 85 percent

Calcium carbonate equivalent: 5 to 15 percent

Houserock family soils

Taxonomic classification: Clayey-skeletal, smectitic, mesic Lithic Haplustalfs

Geomorphic position: summits of mesas

Parent material: residuum weathered from calcareous sandstone and/or residuum weathered from conglomerate

Slope: 2 to 5 percent

Surface fragments: about 65 percent gravel, about 5 percent cobbles, about 5 percent stones

Depth to restrictive feature: 10 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.03 in/hr (very slow)

Available water capacity total inches: 1.5

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: High

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Sandstone Upland, Shallow (JUOS, PIED) 10-14" p.z.

Ecosystem site number: 035XC322AZ

Present native vegetation: Bigelow sagebrush, Wyoming big sagebrush, Stansbury cliffrose, Utah juniper, Colorado pinyon, green Mormon tea

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On top of Cedar Mountain; 36 degrees, 3 minutes, 14 seconds north latitude; 111 degrees, 46 minutes, 12 seconds west longitude.

A—0 to 2 inches; light brown (7.5YR 6/3) extremely gravelly loam; brown (7.5YR 4/3) moist; thin to moderately thick platy structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and common fine roots; common very fine and fine vesicular pores; 45 percent gravel, 20 percent cobble; noneffervescent; slightly alkaline (pH 7.6); abrupt smooth boundary.

Bt1—2 to 5 inches; light brown (7.5YR 6/4) very gravelly clay loam; brown (7.5YR 4/4) moist; weak thin platy structure parting to weak medium and fine subangular blocky; slightly hard, friable, moderately sticky and moderately plastic; common very fine and fine and few medium roots; common very fine and few fine tubular pores; common faint clay films on faces of peds and lining pores; 35 percent gravel, 10 percent cobble; noneffervescent; slightly alkaline (pH 7.8); abrupt smooth boundary.

Bt2—5 to 10 inches; reddish brown (5YR 5/4) very cobbly clay; reddish brown (5YR 4/4) moist; moderate medium and fine subangular blocky structure; hard, firm, moderately sticky and moderately plastic; common very fine and few fine and medium roots; common very fine and few fine and medium tubular pores; few faint clay films on faces of peds and common thin clay films on faces of peds and lining pores; 25 percent gravel, 25 percent cobble; noneffervescent; slightly alkaline (pH 7.8); clear wavy boundary.

Bt3—10 to 19 inches; light brown (7.5YR 6/4) very cobbly sandy clay loam; brown (7.5YR 4/4) moist; weak medium and fine subangular blocky structure; slightly hard, friable, moderately sticky and slightly plastic; common very fine and few fine through coarse roots; common very fine and few fine and medium tubular pores; few faint clay films on faces of peds and common faint clay films lining pores; 25 percent gravel, 20 percent cobble; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

R—19 inches; moderately weathered calcareous sandstone and conglomerate.

Range in Characteristics

Rock fragments: 35 to 55 percent

Depth to bedrock: 10 to 20 inches

A horizon

Hue: 7.5YR, 5YR, 2.5YR

Value: 5 or 6 dry, 3 or 4 moist

Chroma: 3 or 4, dry or moist

Bt horizon

Hue: 7.5YR, 5YR, 2.5YR

Value: 4, 5 or 6 dry, 3 or 4 moist

Chroma: 4 through 6, dry or moist

164—Winkel family, 15 to 55 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,500 to 4,500 feet (1,067 to 1,372 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 200 to 240 days

Map Unit Composition

Winkel family and similar soils: 90 percent

Minor components: 10 percent

- Soils that have no accumulation of calcium carbonate in the profile
- Soils that are deep or very deep to bedrock
- Soils that have gypsum present in the profile
- Skree slopes which are devoid of vegetation
- Soils that have an accumulation of clay in the profile

Properties and Qualities

Winkel family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, thermic, shallow Calcic Petrocalcids

Geomorphic position: summits and side slopes of fan terraces on colluvial slopes of plateaus escarpments and canyons

Parent material: alluvium and/or colluvium derived from limestone and sandstone

Slope: 15 to 55 percent

Surface fragments: about 30 percent gravel, about 10 percent cobbles, about 20 percent stones

Depth to restrictive feature: 14 to 20 inches to petrocalcic

Drainage class: Well drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 1.2

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Slopes, Shallow 6-10" p.z.

Ecosystem site number: 035XE517AZ

Present native vegetation: blackbrush, ephedra, banana yucca

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Tonto Platform; 1,300 feet southwest of Plateau Point; 36 degrees, 5 minutes, 19 seconds north latitude; 112 degrees, 7 minutes, 47 seconds west longitude.

A—0 to 3 inches; very pale brown (10YR 7/3) very stony loam; dark yellowish brown (10YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; few very fine irregular pores; 20 percent gravel, 5 percent cobble, 20 percent stone; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bk1—3 to 8 inches; pink (7.5YR 7/3) very cobbly loam; brown (7.5YR 5/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine through medium roots; few fine tubular pores; many moderately thick calcium carbonate coats on the undersides of rock fragments; 20 percent gravel, 15 percent cobble, and 5 percent stone; violently effervescent; moderately alkaline (pH 8.4); gradual wavy boundary.

Bk2—8 to 15 inches; pink (7.5YR 7/3) very cobbly loam; brown (7.5YR 5/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few fine and medium roots; few fine tubular pores; many coarse soft masses of calcium carbonate; 20 percent gravel, 15 percent cobble, and 5 percent stone; violently effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary.

Bkm—15 to 60 inches; pink (7.5YR 8/3) indurated petrocalcic horizon.

Range in Characteristics

Depth to hardpan: ranges from 14 to 20 inches

A horizon

Hue: 5YR to 10YR

Value: 5 through 7 dry, 3 through 5 moist

Chroma: 2 through 6, dry or moist

Bk horizon

Hue: 5YR, 7.5YR

Value: 4 through 8 dry, 4 through 6 moist

Chroma: 4 through 6, dry or moist

Rock fragments: 35 to 85 percent gravel and cobble

Clay content: 8 to 12 percent

165—Winkel-Rock outcrop complex, 2 to 12 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 1,400 to 2,500 feet (426 to 762 meters)

Mean annual precipitation: 6 to 9 inches (152 to 229 millimeters)

Mean annual air temperature: 64 to 70 degrees F (18 to 21 degrees C)

Mean annual soil temperature: 66 to 72 degrees F (20 to 23 degrees C)

Frost-free period: 230 to 280 days

Map Unit Composition

Winkel and similar soils: 75 percent

Rock outcrop: 15 percent

Minor components: 10 percent

- Talus slopes
- Typic Haplocalcids, 20 to 60 inches deep over basalt bedrock
- Outcrops of gypsum bearing lacustrine sediments
- Soils that have a very cobbly surface phase

Properties and Qualities

Winkel soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, thermic, shallow Calcic Petrocalcids

Geomorphic position: summits and side slopes of mesas

Parent material: residuum weathered from limestone

Slope: 2 to 12 percent

Surface fragments: about 65 percent coarse gravel
Depth to restrictive feature: 30 to 40 inches to bedrock (lithic); 11 to 19 inches to petrocalcic
Drainage class: Well drained
Permeability: about 1.30 in/hr (moderate)
Available water capacity total inches: 1.3
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: very high
Hydrologic group: D
Major Land Resource Area: 30
Land Resource Unit: 30-2
Ecological site name: Limy Upland 6-9" p.z.
Ecosystem site number: 030XB214AZ
Present native vegetation: white bursage, creosotebush, Nevada Mormon tea, white ratany, winterfat
Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: In the Grand Wash; 4,095 feet east of Garden Wash; 36 degrees, 16 minutes, 20 seconds north latitude; 113 degrees, 59 minutes, 25 seconds west longitude.

A1—0 to 2 inches; light brown (7.5YR 6/4) extremely gravelly fine sandy loam, brown (7.5YR 4/4) moist; moderate fine subangular blocky and moderate thin platy structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; few very fine tubular pores; 60 percent gravel; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

A2—2 to 4 inches; light brown (7.5YR 6/4) gravelly fine sandy loam, brown (7.5YR 4/4) moist; strong thin platy structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine irregular and few fine tubular pores; 30 percent gravel; violently effervescent; moderately alkaline (pH 8.2); abrupt wavy boundary.

Bk—4 to 15 inches; pink (7.5YR 8/4) very gravelly loam, reddish yellow (7.5YR 6/6) moist; moderate fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine and fine roots; few very fine tubular pores; weakly cemented with calcium carbonate throughout; many hard, vertically oriented, cylindrical masses of calcium carbonate; violently effervescent; 50 percent gravel; moderately alkaline (pH 8.4); abrupt irregular boundary.

Bkm—15 to 36 inches; pinkish white (7.5YR 8/2) indurated petrocalcic horizon.

R—36 inches; hard basalt bedrock.

Range in Characteristics

Depth to petrocalcic horizon: 11 to 19 inches
 Depth to bedrock: 30 to 40 inches
 Rock fragments: average 35 to 50 percent gravel, 0 to 20 percent cobble

A horizon

Hue: 10YR, 7.5YR, 5YR
 Value: 5 through 7 dry, 3 through 5 moist
 Chroma: 2 through 6, dry or moist
 Effervescence: slightly to violently effervescent
 Calcium carbonate equivalent: 5 to 15 percent

Bk horizons

Hue: 7.5YR, 5YR
 Value: 6 through 8 dry, 4 through 6 moist
 Chroma: 4 through 6, dry or moist
 Reaction: moderately alkaline to strongly alkaline
 Effervescence: strongly to violently effervescent
 Calcium carbonate equivalent: 15 to 35 percent

Rock outcrop

Basalt flows on summits of mesas and plateaus

166—Winona-Rock outcrop-Tusayan complex, 15 to 55 percent slopes

Map Unit Setting

Landform: plateau
Elevation: 4,700 to 7,100 feet (1,433 to 2,164 meters)
Mean annual precipitation: 10 to 14 inches (254 to 356 millimeters)
Mean annual air temperature: 52 to 55 degrees F (11 to 13 degrees C)
Mean annual soil temperature: 54 to 57 degrees F (13 to 15 degrees C)
Frost-free period: 120 to 180 days

Map Unit Composition

Winona and similar soils: 50 percent
 Rock outcrop: 25 percent
 Tusayan and similar soils: 20 percent
 Minor components: 5 percent

- Soils in drainageways that are subject to occasional flooding
- Soils that are greater than 30 inches to bedrock
- Soils that have less calcium carbonate in the profile
- Soils that are less than 8 inches deep
- Soils that have redder colors than the Winona or Tusayan soils
- Soils on hillslope shoulders that have gypsum in the profile

Properties and Qualities

Winona soils

Taxonomic classification: Loamy-skeletal, carbonatic, mesic Lithic Ustic Haplocalcids

Geomorphic position: summits

Parent material: residuum weathered from limestone and sandstone

Slope: 15 to 55 percent

Depth to restrictive feature: 5 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 0.6

Shrink-swell potential: about 1.5 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Limestone Hills 10-14" p.z.

Ecosystem site number: 035XC308AZ

Present native vegetation: muttongrass, Wyoming big sagebrush, blue grama, Stansbury cliffrose, Utah juniper, green Mormon tea

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau, about 1,900 feet north and 2,200 feet east of the southwest corner of section 15, township 32 north, range 4 west; 36 degrees, 9 minutes, 20 seconds north latitude; 112 degrees, 41 minutes, 51.2 seconds west longitude.

A—0 to 2 inches; brown (10YR 5/3) extremely gravelly loam; dark brown (10YR 4/3) moist; weak fine granular structure; soft, very friable, nonsticky and slightly plastic; many very fine roots; common very fine irregular pores; 60 percent gravel, 20 percent cobble, and 5 percent stone; violently effervescent; moderately alkaline (pH 8.0); clear wavy boundary.

Bw—2 to 10 inches; brown (7.5YR 5/3) extremely gravelly loam; dark brown (7.5YR 4/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; 55 percent gravel, 10 percent cobble; violently effervescent; moderately alkaline (pH 8.0); abrupt wavy boundary.

Bk—10 to 17 inches; very pale brown (10YR 7/3) extremely gravelly loam; brown (10YR 5/3) moist; weak medium subangular blocky structure; slightly hard,

friable, slightly sticky and slightly plastic; many very fine roots; common very fine tubular pores; many coarse soft calcium carbonate masses and thin coatings on rock fragments; 50 percent gravel, 10 percent cobble; violently effervescent; moderately alkaline (pH 8.0); abrupt wavy boundary.

R—17 inches; fractured limestone bedrock.

Range in Characteristics

Rock fragments: 35 to 70 percent limestone and chert gravel, channers, cobble, and flagstones

Depth to bedrock: 5 to 20 inches

Calcium carbonate: 40 to 60 percent calcium carbonate equivalent

A horizon

Hue: 5YR, 7.5YR, 10YR

Value: 4 through 6 dry, 3 or 4 moist

Chroma: 2 through 4, dry or moist

Reaction: Slightly or moderately alkaline

Bk horizon

Hue: 5YR, 7.5YR, 10YR

Value: 5, through 7 dry, 3 through 6 moist

Chroma: 2 through 4, dry or moist

Calcium carbonate: Segregated and as coatings on rock fragments

The Bw horizon is not present in all pedons.

Rock outcrop

Summits

Tusayan soils

Taxonomic classification: Loamy-skeletal, carbonatic, mesic Ustic Haplocalcids

Geomorphic position: summits

Parent material: residuum weathered from limestone and sandstone

Slope: 15 to 35 percent

Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 2.3

Shrink-swell potential: about 1.5 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: C

Major Land Resource Area: 35

Land Resource Unit: 35-3

Ecological site name: Limy Slopes 10-14" p.z.

Ecosystem site number: 035XC310AZ

Present native vegetation: needleandthread, black grama, fourwing saltbush, Indian ricegrass, Nevada Mormon tea, Stansbury cliffrose

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: about 2,100 feet north and 2,600 feet west of the southeast corner of section 15, township 32 north, range 4 west; 36 degrees, 9 minutes, 25.2 seconds north latitude; 112 degrees, 41 minutes, 57.2 seconds west longitude.

A—O to 4 inches; brown (10YR 5/3) extremely gravelly fine sandy loam, dark brown (10YR 4/3) moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; 75 percent gravel; violently effervescent; moderately alkaline (pH 8.0); clear wavy boundary.

Bk1—4 to 13 inches; yellowish brown (10YR 5/4) very gravelly loam, dark yellowish brown (10YR 4/4) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; many very fine tubular pores; 50 percent gravel; few medium soft calcium carbonate masses; violently effervescent; moderately alkaline (pH 8.0); clear wavy boundary.

Bk2—13 to 22 inches; light yellowish brown (10YR 6/4) very gravelly loam, yellowish brown (10YR 5/4) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; 55 percent gravel; common medium soft calcium carbonate masses and thin coatings on rock fragments; violently effervescent; moderately alkaline (pH 8.0); abrupt wavy boundary.

R1—22 to 29 inches; fractured, calcium carbonate coated limestone; few very fine roots in fractures; abrupt wavy boundary.

R2—29 inches; limestone.

Range in Characteristics

Depth to bedrock: 20 to 40 inches

Rock fragments: average more than 35 percent in the control section; ranges from 20 to 80 percent gravel

A horizon

Hue: 7.5YR, 10YR

Value: 3 or 4 moist

Chroma: 2 through 4 dry, 3 or 4 moist

Reaction: Slightly or moderately alkaline

Calcium carbonate equivalent: Less than 40 percent, generally disseminated

B horizon

Hue: 7.5YR, 10YR

Value: 4 through 6 dry, 4 or 5 moist

Chroma: 2 through 6, dry or moist

Texture: loam, clay loam (20 to 28 percent clay)

Reaction: slightly to strongly alkaline

Calcium carbonate equivalent: More than 40 percent as coatings on gravel, nodules and calcareous sedimentary gravel

C horizon

Hue: 7.5YR, 10YR

Value: 5 through 8 dry, 4 or 5 moist

Chroma: 1 through 6 dry, 3 through 6 moist

Texture: sandy loam, loam (10 to 25 percent clay)

Calcium carbonate equivalent: more than 40 percent as nodules and calcareous sedimentary gravel

167—Wodomont-Topocoba-Plumasano families complex, 2 to 15 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,600 to 6,200 feet (1,707 to 1,890 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)

Mean annual soil temperature: 50 to 54 degrees F (11 to 13 degrees C)

Frost-free period: 135 to 150 days

Map Unit Composition

Wodomont family and similar soils: 40 percent

Topocoba family and similar soils: 30 percent

Plumasano family and similar soils: 25 percent

Minor components: 5 percent

- Soils that are deep to bedrock
- Soils that have less than 35 percent by volume rock fragments in the profile
- Soils in drainageways that are subject to occasional flooding
- Rock outcrop

- Soils that have an accumulation of clay in the profile

Properties and Qualities

Wodomont family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Calciustepts
Geomorphic position: summits and sideslopes of low hills and ridges
Parent material: residuum weathered from limestone and sandstone
Slope: 2 to 15 percent
Surface fragments: about 40 percent gravel
Depth to restrictive feature: 6 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Permeability: about 4.00 in/hr (moderately rapid)
Available water capacity total inches: 1.2
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: very high
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-6
Ecological site name: Limestone Upland (JUOS, PIED) 13-17" p.z.
Ecosystem site number: 035XF619AZ
Present native vegetation: Artemisia, Utah juniper, Colorado pinyon, Stansbury cliffrose, green Mormon tea
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On Tuckup Point; 2.35 miles west of Schmutz Spring; 36 degrees, 21 minutes, 2 seconds north latitude; 112 degrees, 57 minutes, 31 second west longitude.

A—0 to 3 inches; brown (7.5YR 4/3) very gravelly loam; dark brown (7.5YR 3/3) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine roots; common very fine tubular pores; 40 percent gravel; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bw—3 to 8 inches; brown (7.5YR 4/3) very gravelly loam; dark brown (7.5YR 3/3) moist; moderate medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many fine and medium roots; common fine tubular pores; 40 percent gravel, 5

percent cobble; violently effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bk—8 to 15 inches; brown (7.5YR 4/4) very flaggy loam; dark brown (7.5YR 3/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; common fine through coarse roots; common fine and medium tubular pores; 20 percent gravel, 5 percent cobble, and 20 percent flagstones; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

R—15 inches; limestone bedrock.

Range in Characteristics

Clay content (control section): 8 to 15 percent
 Rock fragment content (control section): 35 to 50 percent

Depth to bedrock: 6 to 20 inches

A horizon

Hue: 7.5YR, 10YR
 Value: 3 through 5 dry, 3 or 4 moist
 Chroma: 3 or 4, dry or moist

Bw horizon

Hue: 7.5YR, 10YR
 Value: 3 or 4, dry or moist
 Chroma: 3 or 4, dry or moist
 Calcium carbonate equivalent: 5 to 10 percent

Bk horizon

Hue: 7.5YR, 10YR
 Value: 4 or 5 dry, 3 or 4 moist
 Chroma: 3 or 4, dry or moist
 Calcium carbonate equivalent: 15 to 25 percent

Some pedons do not have a Bw horizon.

Topocoba family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic, shallow Petrocalcic Paleustalfs

Geomorphic position: summits and sideslopes of low hills and ridges

Parent material: residuum weathered from limestone and sandstone

Slope: 2 to 15 percent

Surface fragments: about 10 percent cobbles, about 50 percent gravel

Depth to restrictive feature: 15 to 30 inches to bedrock (lithic); 10 to 20 inches to petrocalcic

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)
Available water capacity total inches: 1.3
Shrink-swell potential: about 1.0 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: very high
Hydrologic group: D
Major Land Resource Area: 35
Land Resource Unit: 35-6
Ecological site name: Limestone Upland (JUOS, PIED) 13-17" p.z.
Ecosystem site number: 035XF619AZ
Present native vegetation: Artemisia, Utah juniper, Colorado pinyon, Stansbury cliffrose, green Mormon tea
Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On Tuckup Point; 1.81 miles north of Willow Spring; 36 degrees, 19 minutes, 39 seconds north latitude; 112 degrees, 57 minutes, 28 seconds west longitude.

A—0 to 2 inches; strong brown (7.5YR 4/6) very gravelly silt loam; dark brown (7.5YR 3/4) moist; moderate fine subangular blocky structure parting to strong very fine angular blocky; soft, very friable, slightly sticky and nonplastic; many very fine roots; many very fine irregular pores; 45 percent gravel, 10 percent cobble; noneffervescent; slightly alkaline (pH 7.8); abrupt smooth boundary.

Bt—2 to 8 inches; brown (7.5YR 4/4) very gravelly silt loam; dark brown (7.5YR 3/4) moist; moderate fine and medium subangular blocky structure; hard, firm, moderately sticky and moderately plastic; many very fine through coarse roots; common very fine and fine tubular pores; common faint clay films bridging sand grains; few faint clay films lining pores; 40 percent gravel, 5 percent cobble; slightly effervescent; moderately alkaline (pH 8.0); clear smooth boundary.

Bk—8 to 15 inches; brown (7.5YR 5/4) very gravelly loam; brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few fine tubular pores; many very fine and fine soft seam and masses of calcium carbonate; 30 percent gravel, 5 percent cobble, and 5 percent flagstones; violently effervescent; moderately alkaline (pH 8.4); abrupt irregular boundary.

Bkm—15 to 19 inches; indurated petrocalcic horizon.

R—19 inches; limestone bedrock.

Range in Characteristics

Rock fragments: Ranges from 20 to 70 percent
 Clay content: 20 to 22 percent
 Depth to petrocalcic horizon: 10 to 20 inches
 Depth to bedrock: 15 to 30 inches
 Calcium carbonate equivalent: Less than 30 percent above the hardpan
 Organic matter: averages more than 1 percent in the surface

A horizon

Hue: 5YR, 7.5YR
 Value: 4 or 5 dry, 3 or 4 moist
 Chroma: 3 though 6, dry or moist

Bt horizon

Hue: 5YR, 7.5YR
 Value: 4 or 5 dry, 3 or 4 moist
 Chroma: 3 or 4 moist

Bk horizon

Hue: 5YR, 7.5YR
 Value: 4 or 5, dry or moist
 Chroma: 3 or 4, dry or moist

Plumasano family soils

Taxonomic classification: Coarse-loamy, mixed, superactive, mesic Aridic Haplustepts

Geomorphic position: summits and sideslopes of low hills and ridges

Parent material: over residuum weathered from sandstone and siltstone

Slope: 2 to 15 percent

Surface fragments: about 10 percent gravel

Depth to restrictive feature: 20 to 40 inches to bedrock (lithic); 15 to 25 inches to bedrock (paralithic)

Drainage class: Well drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 2.3

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Medium

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Loamy Upland 13-17" p.z.

Ecosystem site number: 035XF605AZ

Present native vegetation: Wyoming big sagebrush, blue grama, muttongrass, western wheatgrass, other evergreen trees

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On Tuckup Point; 1.78 miles north of Willow Spring; 36 degrees, 19 minutes, 38 seconds north latitude; 112 degrees, 57 minutes, 20 seconds west longitude.

A1—0 to 1 inch; light brown (7.5YR 6/4) loam; brown (7.5YR 4/4) moist; moderate thin platy structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; many very fine vesicular and common fine tubular pores; 10 percent gravel; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

A2—1 to 4 inches; light brown (7.5YR 6/3) loam; dark brown (7.5YR 3/4) moist; weak coarse subangular blocky structure parting to moderate very fine granular; soft, very friable, slightly sticky and slightly plastic; many very fine and fine and common medium and coarse roots; many very fine and fine and common medium tubular pores; 10 percent gravel, violently effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

A3—4 to 9 inches; light brown (7.5YR 6/4) loam; brown (7.5YR 4/4) moist; moderate fine and medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine through coarse roots; common fine and medium tubular pores; 10 percent gravel; violently effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

Bw—9 to 19 inches; pink (5YR 7/4) loam; reddish brown (5YR 5/4) moist; moderate medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common fine and many medium and coarse roots; common fine and few medium tubular pores; 30 percent rock fabric; violently effervescent; strongly alkaline (pH 8.6); clear irregular boundary.

Cr—19 to 38 inches; highly fractured, moderately weathered calcareous fine sandstone bedrock; clear wavy boundary.

R—38 inches; calcareous fine sandstone bedrock.

Range in Characteristics

Particle size control section: 8 to 15 percent clay
Depth to calcium carbonate: 5 to 25 inches
Depth to bottom of cambic: 11 to 24 inches

A horizon

Hue: 7.5YR, 10YR
Value: 4 through 6 dry, 3 through 5 moist
Chroma: 3 or 4 dry, 2 through 4 moist

Bw horizon

Hue: 7.5YR, 10YR
Value: 4 or 6 dry, 3 or 4 moist
Chroma: 3 or 4 dry, 2 through 6 moist

168—Wutoma-Lozinta complex, 15 to 60 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,800 to 7,200 feet (1,767 to 2,194 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)

Mean annual soil temperature: 50 to 54 degrees F (11 to 13 degrees C)

Frost-free period: 135 to 150 days

Map Unit Composition

Wutoma and similar soils: 45 percent

Lozinta and similar soils: 40 percent

Minor components: 15 percent

- Bilburc soils
- Yumtheska soils
- Cinder land

Properties and Qualities

Wutoma soils

Taxonomic classification: Ashy-skeletal over fragmental or cindery, mixed, mesic Vitrandic Haplustepts

Geomorphic position: side slopes of cinder cones

Parent material: basaltic volcanic ash and/or cinders

Slope: 35 to 60 percent

Surface fragments: about 70 percent coarse gravel, about 10 percent cobbles

Drainage class: Somewhat excessively drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 1.6

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: High

Hydrologic group: B

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Cinder Hills (PIED, JUOS)
13-17" p.z.

Ecosystem site number: 035XF609AZ

Present native vegetation: Colorado pinyon, Wyoming big sagebrush, Utah juniper, banana yucca, green Mormon tea

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In the Uinkaret Mountains; 1.44 miles north of Sage Flat Reservoir; 36 degrees, 13 minutes, 26 seconds north latitude; 113 degrees, 10 minutes, 32 seconds west longitude.

A1—0 to 1 inch; light brown (7.5YR 6/3) extremely gravelly loamy coarse sand consisting of ash and cinders; dark brown (7.5YR 3/4) moist; single grain; loose, nonsticky and nonplastic; common very fine through medium and few coarse irregular pores; 75 percent gravel-sized cinders and 10 percent cobble-sized cinders; noneffervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

A2—1 to 4 inches; light brown (7.5YR 6/3) very gravelly loamy coarse sand consisting of ash and cinders; dark brown (7.5YR 3/4) moist; weak thick platy structure; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; common very fine through medium and few coarse irregular pores; 35 percent cinders; noneffervescent; moderately alkaline (pH 8.0); clear smooth boundary.

Bw1—4 to 12 inches; pale brown (10YR 6/3) very gravelly sandy loam; dark brown (10YR 3/3) moist; weak fine granular structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and few medium through coarse roots; common very fine and few fine and medium irregular pores; few thin calcium carbonate coats on underside of rock fragments; 35 percent cinders; strongly effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bw2—12 to 18 inches; light brownish gray (10YR 6/2) very gravelly loamy sand; dark yellowish brown (10YR 3/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine and few medium and coarse roots; common very fine and few fine and medium irregular pores; few thin calcium carbonate coats on underside of rock fragments; 30 percent gravel-sized cinders, 10 percent cobble-sized cinders; violently effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

2C—18 to 60 inches; very dark gray (N 3/0) cinders; black (N 1/0) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine and few fine through coarse roots; common very fine through coarse irregular pores; common thin calcium carbonate coats on rock fragments; 80 percent cinders; violently effervescent; moderately alkaline (pH 8.2).

Range in Characteristics

Depth to cinders: 11 to 20 inches
Calcium carbonate equivalent: 0 to 10 percent

A horizon

Hue: 10YR, 7.5YR
Value: 4 through 6 dry, 3 or 4 moist
Chroma: 3 or 4 dry, 1 through 4 moist

Bw horizons

Hue: 10YR, 7.5YR
Value: 4 through 6 dry, 3 or 4 moist
Chroma: 1 through 4, dry or moist
Reaction: neutral to moderately alkaline
Rock fragments: 60 to 80 percent cinders

Lozinta soils

Taxonomic classification: Ashy-skeletal over fragmental or cindery, mixed, mesic Vitrandic Haplustepts

Geomorphic position: side slopes of cinder cones

Parent material: basaltic volcanic ash and/or cinders

Slope: 15 to 35 percent

Surface fragments: about 45 percent coarse gravel, about 5 percent cobbles

Drainage class: Somewhat excessively drained

Permeability: about 4.00 in/hr (moderately rapid)

Available water capacity total inches: 1.2

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Medium

Hydrologic group: B

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Cinder Hills (PIED, JUOS)
13-17" p.z.

Ecosystem site number: 035XF609AZ

Present native vegetation: Colorado pinyon, Wyoming big sagebrush, Utah juniper, banana yucca, green Mormon tea

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: In the Uinkaret Mountains; 3,530 feet north of Big Spring; 36 degrees, 20 minutes, 46 seconds north latitude; 113 degrees, 11 minutes, 12 seconds west longitude.

A—0 to 4 inches; pale brown (10YR 6/3) very gravelly coarse sandy loam consisting of ash and cinders; dark yellowish brown (10YR 3/4) moist; weak thick platy structure; slightly hard, very friable, nonsticky and

nonplastic; few very fine roots; common very fine through medium and few coarse irregular pores; 45 percent gravel-sized cinders, 5 percent cobble-sized cinders; noneffervescent; slightly alkaline (pH 7.8); clear smooth boundary.

Bw1—4 to 10 inches; pale brown (10YR 6/3) very gravelly sandy loam; dark brown (10YR 3/3) moist; weak fine granular structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and few medium through coarse roots; common very fine and few fine and medium irregular pores; few thin calcium carbonate coats on the undersides of rock fragments; 35 percent gravel-sized cinders; strongly effervescent; moderately alkaline (pH 8.2); clear smooth boundary.

Bw2—10 to 22 inches; light brownish gray (10YR 6/2) very gravelly loamy sand; dark yellowish brown (10YR 3/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine and few medium and coarse roots; common very fine and few fine and medium irregular pores; common thin calcium carbonate coats on underside of rock fragments; 30 percent gravel-sized cinders, 10 percent cobble-sized cinders; violently effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

2C—22 to 60 inches; very dark gray (N 3/0) cinders; black (N 1/0) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine and few fine through coarse roots; common very fine through coarse irregular pores; common thin calcium carbonate coats on rock fragments; 80 percent cinders; violently effervescent; moderately alkaline (pH 8.2).

Range in Characteristics

Depth to cinders: 20 to 40 inches
Reaction: neutral to moderately alkaline
Calcium carbonate equivalent: 0 to 10 percent

A horizon

Hue: 10YR, 7.5YR, 5YR
Value: 4 through 6 dry, 3 or 4 moist
Chroma: 2 through 4, dry or moist

Bw horizons

Hue: 10YR, 7.5YR, 5YR
Value: 4 or 5 dry, 3 or 4 moist
Chroma: 2 through 4, dry or moist
Rock fragments: 65 to 80 percent cinders

169—Yellowhorse-Luzena-Sponiker association, 2 to 15 percent slopes

Map Unit Setting

Landform: plateau
Elevation: 5,900 to 6,100 feet (1,798 to 1,860 meters)
Mean annual precipitation: 14 to 25 inches (356 to 635 millimeters)
Mean annual air temperature: 45 to 48 degrees F (7 to 9 degrees C)
Mean annual soil temperature: 47 to 50 degrees F (9 to 11 degrees C)
Frost-free period: 80 to 150 days

Map Unit Composition

Yellowhorse and similar soils: 45 percent
Luzena and similar soils: 25 percent
Sponiker and similar soils: 15 percent
Minor components: 15 percent

- Loamy, very deep soils in drainageways that are subject to occasional flooding
- Kellypoint soils
- Rock outcrop on ridges and escarpments
- Yellowhorse and Luzena soils that have an extremely stony surface phase

Properties and Qualities

Yellowhorse soils

Taxonomic classification: Fine, smectitic, mesic Leptic Udic Haplusterts
Geomorphic position: foot slopes and toeslopes of hills and ridges of basalt flows
Parent material: colluvium and/or residuum weathered from basalt
Slope: 2 to 8 percent
Surface fragments: about 20 percent cobbles, about 25 percent coarse gravel
Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)
Drainage class: Well drained
Permeability: about 0.01 in/hr (very slow)
Available water capacity total inches: 3.9
Shrink-swell potential: about 10.0 LEP (very high)
Flooding hazard: None
Seasonal water table minimum depth: greater than 6 feet
Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-8

Ecological site name: Loamy Hills (PIPO) 17-25" p.z.

Ecosystem site number: 035XH805AZ

Present native vegetation: ponderosa pine, muttongrass, Gambel oak, Ross sedge, big wildrye

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Shivwits Plateau; 4,983 feet southwest of End Spring; 36 degrees, 8 minutes, 7 seconds north latitude; 113 degrees, 21 minutes, 46 seconds west longitude.

A1—0 to 2 inches; dark yellowish brown (10YR 4/4) cobbly silty clay loam; dark brown (10YR 3/3) moist; strong fine granular structure; slightly hard, friable, very sticky and moderately plastic; common very fine roots; many very fine and fine tubular pores; 15 percent gravel, 15 percent cobble; noneffervescent; neutral (pH 7.0); abrupt smooth boundary.

A2—2 to 7 inches; dark grayish brown (10YR 4/2) cobbly silty clay loam; dark brown (10YR 3/3) moist; weak medium subangular blocky structure parting to strong fine granular; slightly hard, friable, very sticky and very plastic; many very fine through coarse roots; many very fine and fine tubular pores; 5 percent gravel, 10 percent cobble; noneffervescent; neutral (pH 7.0); clear smooth boundary.

Bt—7 to 14 inches; brown (7.5YR 4/3) clay; dark brown (7.5YR 3/3) moist; moderate coarse subangular blocky structure parting to strong very fine angular blocky; hard, firm, very sticky and very plastic; few very fine through coarse roots; few fine tubular pores; 5 percent gravel, 5 percent cobble; few faint clay films on faces of peds; noneffervescent, neutral (pH 7.0); clear wavy boundary.

Btss—14 to 26 inches; brown (7.5YR 4/4) clay; dark brown (7.5YR 3/3) moist; strong coarse prismatic structure parting to strong medium angular blocky; very hard, very firm, very sticky and very plastic; few very fine through coarse roots; few fine tubular pores; 5 percent gravel, 5 percent cobble; many distinct clay films on faces of peds; common pressure faces and intersecting slickensides; noneffervescent, neutral (pH 7.0); abrupt irregular boundary.

R—26 inches; basalt bedrock.

Range in Characteristics

Depth to bedrock: 20 to 40 inches

Clay content: 35 to 60 percent

Reaction: neutral to slightly alkaline

Cracking: deep wide cracks are open from 90 to 150 days cumulative

A horizon

Hue: 10YR, 7.5YR

Value: 3 through 5 dry, 2 or 3 moist

Chroma: 2 through 6, dry or moist

Bt and Btss horizons

Hue: 5YR, 7.5YR

Value: 3 through 5 dry, 3 or 4 moist

Chroma: 2 through 6, dry or moist

Luzena soils

Taxonomic classification: Clayey, smectitic, mesic Lithic Argiustolls

Geomorphic position: summits and side slopes of hills and ridges of basalt flows

Parent material: colluvium and/or residuum weathered from basalt

Slope: 2 to 15 percent

Surface fragments: about 60 percent coarse gravel, about 10 percent cobbles

Depth to restrictive feature: 7 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.01 in/hr (very slow)

Available water capacity total inches: 1.8

Shrink-swell potential: about 7.0 LEP (high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Basalt Upland (JUOS) 13-17" p.z.

Ecosystem site number: 035XF620AZ

Present native vegetation: Utah juniper, muttongrass, Colorado pinyon, Stansbury cliffrose, bottlebrush squirreltail, turbinella oak

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Shivwits Plateau; 4,386 feet south of Lake Flat; 36 degrees, 7 minutes, 54 seconds north latitude; 113 degrees, 31 minutes, 22 seconds west longitude.

A—0 to 1 inch; brown (7.5YR 5/3) extremely gravelly sandy clay loam; brown (7.5YR 3/3) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; common very fine tubular pores; 60 percent gravel; 10 percent

cobble; noneffervescent; neutral (pH 7.0); abrupt smooth boundary.

AB—1 to 3 inches; brown (7.5YR 4/3) loam; dark brown (7.5YR 3/2) moist; moderate medium subangular blocky structure; soft, very friable, slightly sticky and moderately plastic; many very fine and fine and common medium roots; common very fine through medium tubular pores; 10 percent gravel; common faint clay films on faces of peds; noneffervescent; neutral (pH 7.0); abrupt smooth boundary.

Bt1—3 to 8 inches; brown (7.5YR 4/3) gravelly silty clay; very dark brown (7.5YR 2.5/2) moist; strong fine and medium angular blocky structure; hard, firm, very sticky and very plastic; many fine and medium roots; many fine and medium tubular pores; 10 percent gravel, 5 percent cobble; common faint clay films on faces of peds; noneffervescent; neutral (pH 7.0); clear smooth boundary.

Bt2—8 to 15 inches; brown (7.5YR 4/3) cobbly clay; dark brown (7.5YR 3/2) moist; strong fine angular blocky structure; very hard, firm, very sticky and very plastic; common fine and medium roots; common fine and medium tubular pores; 5 percent gravel, 10 percent cobble; noneffervescent; neutral (pH 7.0); abrupt irregular boundary.

R—15 inches; basalt bedrock.

Range in Characteristics

Rock fragments: 15 to 35 percent in the particle size control section

Depth to bedrock: 7 to 20 inches. Some pedons contain a layer of weathered bedrock, paralithic contact, less than 3 inches thick above the lithic contact.

Reaction: moderately acid to moderately alkaline

A horizon

Hue: 5YR, 7.5YR, 10YR

Value: 3 through 5 dry, 2 or 3 moist

Chroma: 2 or 3, dry or moist

Bt horizon

Hue: 5YR, 7.5YR

Value: 3, 4 or 5 dry, 2.5 or 3 moist

Chroma: 2 or 3, dry or moist

Texture: clay, silty clay, clay loam, silty clay loam (35 to 60 percent clay)

Some pedons contain accumulations of calcium carbonate at the soil-rock interface.

Sponiker soils

Taxonomic classification: Fine, smectitic, mesic

Pachic Argiustolls

Geomorphic position: terraces of broad drainageways

Parent material: alluvium

Slope: 2 to 4 percent

Drainage class: Well drained

Permeability: about 0.01 in/hr (very slow)

Available water capacity total inches: 10.3

Shrink-swell potential: about 10.0 LEP (very high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Negligible

Hydrologic group: C

Major Land Resource Area: 35

Land Resource Unit: 35-8

Ecological site name: Loamy Terrace (PIPO) 17-25" p.z.

Ecosystem site number: 035XH806AZ

Present native vegetation: Wyoming big sagebrush, muttongrass, ponderosa pine, prairie Junegrass, western wheatgrass, Gambel oak

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Shivwits Plateau; 3,684 feet southwest of Pine Valley; 36 degrees, 6 minutes, 56 seconds north latitude; 113 degrees, 27 minutes, 18 seconds west longitude.

Oi—0 to 1.5 inches; ponderosa pine leaf litter; abrupt smooth boundary.

A—1.5 to 3 inches; brown (7.5YR 4/3) silt loam; very dark brown (7.5YR 2.5/3) moist; weak fine subangular blocky and granular structure; soft, very friable, moderately sticky and moderately plastic; common very fine roots; few very fine tubular and irregular pores; noneffervescent; neutral (pH 6.6); abrupt smooth boundary.

Bt1—3 to 10 inches; brown (7.5YR 4/3) silty clay loam; very dark brown (7.5YR 2.5/3) moist; moderate medium subangular blocky structure; slightly hard, very friable, moderately sticky and moderately plastic; few very fine, common fine, few medium roots; few very fine and fine tubular pores; common faint clay films on faces of peds and common distinct clay films lining pores; noneffervescent; neutral (pH 6.6); clear smooth boundary.

Bt2—10 to 26 inches; brown (7.5YR 4/3) silty clay;

very dark brown (7.5YR 2.5/2) moist; weak coarse prismatic structure parting to moderate coarse subangular blocky; hard, friable, very sticky and very plastic; few fine through medium roots; common very fine, few fine through coarse tubular and common very fine and few fine irregular pores; common faint clay films on faces of pedis and common distinct clay films lining pores; noneffervescent; neutral (pH 6.8); gradual smooth boundary.

Bt3—26 to 41 inches; brown (7.5YR 4/3) silty clay; very dark brown (7.5YR 2.5/2) moist; weak very coarse prismatic structure parting to medium and coarse angular blocky; very hard, firm, very sticky and very plastic; few very fine and fine, common medium and few coarse roots; common very fine and few fine through coarse tubular pores and common very fine irregular pores; many faint and few distinct clay films on faces of pedis and common distinct clay films lining pores; common, horizontally oriented, 1- to 5-millimeter-thick lenses of brown (7.5YR 5/4) silt loam, dark brown (7.5YR 3/4) moist; noneffervescent; neutral (pH 6.8); abrupt smooth boundary.

2Btss—41 to 60 inches; dark brown (7.5YR 3/2) clay; very dark brown (7.5YR 2.5/2) moist; strong medium prismatic structure parting to strong fine and medium angular blocky; very hard, firm, very sticky and very plastic; few fine through coarse roots; common very fine tubular pores; many pressure faces and common intersecting slickensides; noneffervescent; 5 percent gravel; neutral (pH 6.8).

Range in Characteristics

Clay content: averages 40 to 55 percent in the particle size control section

Rock fragments: less than 35 percent in the particle size control section

Reaction: neutral to slightly alkaline

Organic matter content: 1 to 4 percent throughout

A horizon

Hue: 5YR, 7.5YR

Value: 3 or 4 dry, 2.5 or 3 moist

Chroma: 2 or 3, dry or moist

Bt horizons

Hue: 5YR, 7.5YR

Value: 3 through 5 dry, 2.5 or 3 moist

Chroma: 2 through 4, dry or moist

170—Yumtheska-Bilburc association, 10 to 45 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 6,200 to 6,800 feet (1,889 to 2,073 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)

Mean annual soil temperature: 50 to 54 degrees F (11 to 13 degrees C)

Frost-free period: 135 to 150 days

Map Unit Composition

Yumtheska and similar soils: 50 percent

Bilburc and similar soils: 40 percent

Minor components: 10 percent

- Phizphre very gravelly loam, 8 to 15 percent slopes
- Rock outcrop
- Soils that have a cobbly surface phase
- Soils that have a petrocalcic horizon above the bedrock
- Soils that do not have calcium carbonate accumulations and are slightly acid throughout

Properties and Qualities

Yumtheska soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Calciustolls

Geomorphic position: shoulders and side slopes of low hills and ridges

Parent material: colluvium and/or residuum weathered from limestone and sandstone

Slope: 10 to 45 percent

Surface fragments: about 10 percent subangular stones, about 50 percent coarse gravel, about 10 percent cobbles

Depth to restrictive feature: 11 to 17 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.03 in/hr (very slow)

Available water capacity total inches: 1.1

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Limestone Slopes (PIED, JUOS)
13-17" p.z.

Ecosystem site number: 035XF613AZ

Present native vegetation: muttongrass, Artemisia,
Stansbury cliffrose, Colorado pinyon, Utah juniper

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Shivwits Plateau; 1.53 miles southwest of Mathis Spring; 36 degrees, 4 minutes, 52 seconds north latitude; 113 degrees, 37 minutes, 18 seconds west longitude.

A1—0 to 2 inches; dark brown (7.5YR 3/3) very
gravelly silt loam, very dark brown (7.5YR 2.5/3) moist;
weak fine subangular blocky dm M M M M M M
gravelly si R gm

s
weak fine subangular blocky dm M M M M M
seco gm

gm
g
subangular
gravelly si
graveb

Present native vegetation: muttongrass, Utah juniper, Wyoming big sagebrush, blue grama, Colorado pinyon

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Shivwits Plateau; 1.80 miles southwest of Mathis Spring; 36 degrees, 4 minutes, 45 seconds north latitude; 113 degrees, 37 minutes, 47 seconds west longitude.

A1—0 to 1 inch; brown (7.5YR 4/3) extremely gravelly very fine sandy loam, dark brown (7.5YR 3/3) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; common very fine tubular pores; 70 percent gravel; noneffervescent; neutral (pH 6.8); abrupt smooth boundary.

A2—1 to 6 inches; brown (7.5YR 4/3) clay loam, dark brown (7.5YR 3/3) moist; strong medium subangular blocky structure; slightly hard, friable, very sticky and very plastic; many very fine and fine and common medium and coarse roots; many very fine and common medium tubular pores; noneffervescent; 10 percent gravel; neutral (pH 6.8); clear wavy boundary.

Bt—6 to 12 inches; brown (7.5YR 4/3) clay, dark brown (7.5YR 3/3) moist; weak medium prismatic structure parting to moderate medium angular blocky; hard, firm, very sticky and very plastic; common fine through coarse roots; few medium tubular pores; common faint clay films on faces of peds; noneffervescent; neutral (pH 6.8); clear wavy boundary.

Btss—12 to 19 inches; reddish brown (5YR 4/4) clay; reddish brown (5YR 4/4) moist; strong medium prismatic structure parting to strong medium angular blocky; very hard, very firm, very sticky and very plastic; common medium and few coarse roots; few medium tubular pores; many distinct clay films on faces of peds; many slickensides; slightly effervescent; 5 percent gravel; neutral (pH 6.8); clear wavy boundary.

Btkss—19 to 29 inches; reddish brown (5YR 4/4) gravelly clay, yellowish red (5YR 4/6) moist; strong coarse prismatic structure parting to strong medium and coarse angular blocky; very hard, very firm, very sticky and very plastic; few fine and medium roots; few fine and medium tubular pores; many distinct clay films on faces of peds; many slickensides; strongly effervescent; 20 percent gravel; moderately alkaline (pH 8.0); clear wavy boundary.

Btk—29 to 35 inches; reddish brown (5YR 4/3) and reddish yellow (7.5YR 6/6) gravelly clay, yellowish red (5YR 4/6) and reddish yellow (7.5YR 6/6) moist; strong fine angular blocky structure; hard, firm, very sticky and very plastic; few fine and medium roots; few fine tubular pores; few faint clay films lining pores; many soft and medium masses of calcium carbonate; violently effervescent; 20 percent gravel; moderately alkaline (pH 8.2); abrupt irregular boundary.

R—35 inches; limestone bedrock.

Range in Characteristics

Depth to bedrock: 23 to 39 inches

Rock fragments: average less than 15 percent in the particle size control section

Clay content: averages 35 to 55 percent in the particle size control section

A horizons

Hue: 7.5YR, 10YR

Value: 4 or 5 dry, 3 or 4 moist

Chroma: 2 or 3, dry or moist

The mollic horizon may include the upper part of the argillic horizon.

Bt and Btss horizons

Hue: 5YR, 7.5YR

Value: 4 or 5 dry, 2 or 3 moist

Slickensides: few to many, may occur in both or either the Bt or Btk horizons

Cracking: cracks 5 mm or more wide are present within 125 cm of the surface in most years.

Btk horizon

Hue: 2.5YR, 5YR, 7.5YR

Value: 4 through 6, dry or moist

Chroma: 2 through 6, dry or moist

Calcium carbonate equivalent: averages 15 to 40 percent

Some pedons may have Bk horizons in the lower part of the profile.

171—Yumtheska-Katzine-Rock outcrop complex, 2 to 30 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 6,200 to 6,500 feet (1,889 to 1,981 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)

Mean annual soil temperature: 50 to 54 degrees F (11 to 13 degrees C)

Frost-free period: 135 to 150 days

Map Unit Composition

Yumtheska and similar soils: 50 percent

Katzine and similar soils: 20 percent

Rock outcrop: 20 percent

Minor components: 10 percent

- Moderately deep to deep, loamy soils in drainageways
- Shallow to moderately deep, loamy soils on hillsides
- Katzine very gravelly fine sandy loam
- Yumtheska very gravelly sandy loam

Properties and Qualities

Yumtheska soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Calciustolls

Geomorphic position: summits and side slopes of hills and ridges

Parent material: colluvium and/or residuum weathered from limestone and sandstone

Slope: 2 to 30 percent

Surface fragments: about 5 percent cobbles, about 50 percent coarse gravel

Depth to restrictive feature: 7 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 1.2

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Limestone Slopes (PIED, JUOS) 13-17" p.z.

Ecosystem site number: 035XF613AZ

Present native vegetation: muttongrass, Artemisia, Stansbury cliffrose, Colorado pinyon, Utah juniper

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: about 2,590 feet north and 2,540 feet west of the southeast corner of section 11, township

34 north, range 13 west; 36 degrees, 21 minutes, 29.9 seconds north latitude; 113 degrees, 39 minutes, 24.4 seconds west longitude.

A—0 to 2 inches; brown (10YR 5/3) very gravelly loam, dark brown (10YR 3/3) moist; moderate thick platy structure; soft, very friable, slightly sticky and slightly plastic; many fine and few medium roots; common fine irregular pores; slightly effervescent; 50 percent gravel, 5 percent cobble; slightly alkaline (pH 7.4); clear smooth boundary.

Bk1—2 to 8 inches; dark brown (10YR 4/3) very channery loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and few medium roots; common fine tubular pores; common thin calcium carbonate coatings on undersides of rock fragments; 50 percent channers; slightly effervescent; moderately alkaline (pH 8.0); abrupt wavy boundary.

Bk2—8 to 14 inches; light gray (10YR 7/2) very channery loam, grayish brown (10YR 5/2) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; common fine tubular pores; common thin calcium carbonate coatings and pendants on rock fragments; 35 percent channers; violently effervescent; moderately alkaline (pH 8.0); abrupt irregular boundary.

R—14 inches; limestone bedrock with a thin laminar calcium carbonate coating on upper surface.

Range in Characteristics

Rock fragments: average more than 35 percent in the particle size control section

Clay content: averages 18 to 20 percent in the particle size control section

Depth to bedrock: 7 to 20 inches

A horizon

Hue: 7.5YR, 10YR

Value: 3 through 5, dry or moist

Chroma: 2 or 3, dry or moist

Organic matter: averages 1 to 5 percent in the surface

Bk horizon(s)

Hue: 7.5YR, 10YR

Value: 3 through 7 dry, 3 through 5 moist

Chroma: 2 through 4, dry or moist

Calcium carbonate equivalent: 15 to 40 percent

Katzine soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Aridic Calciustepts

Geomorphic position: back slopes and foot slopes of hills and ridges

Parent material: colluvium derived from limestone and sandstone

Slope: 5 to 30 percent

Surface fragments: about 45 percent coarse gravel

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 4.7

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: C

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Loamy Upland, Gravelly (PIED, JUOS) 13-17" p.z.

Ecosystem site number: 035XF614AZ

Present native vegetation: Artemisia, muttongrass, Stansbury cliffrose, Utah juniper, Colorado pinyon

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: about 1,900 feet north and 2,500 feet west of the southeast corner of section 17, township 35 north, range 12 west; 36 degrees, 25 minutes, 52.9 seconds north latitude; 113 degrees, 36 minutes, 12.8 seconds west longitude.

A—0 to 2 inches; brown (7.5YR 5/3) very gravelly loam, dark brown (7.5YR 4/3) moist; weak thin platy structure; slightly hard, friable, slightly sticky and nonplastic; many fine and very fine roots; many fine and very fine irregular pores; 40 percent gravel; slightly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

Bw—2 to 8 inches; brown (7.5YR 5/3) very gravelly loam, dark brown (7.5YR 4/3) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; many fine and very fine tubular and irregular pores; few fine seams and coatings of calcium carbonate on rock fragments, 5 percent calcium carbonate equivalent; 40 percent gravel; strongly effervescent; moderately alkaline (pH 8.0); clear smooth boundary.

Bk1—8 to 20 inches; light brown (7.5YR 6/4) very gravelly loam, brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine

and very fine and few medium roots; common fine and very fine tubular and irregular pores; common fine calcium carbonate seams and coatings on rock fragments, 17 percent calcium carbonate equivalent; 35 percent gravel; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bk2—20 to 31 inches; light brown (7.5YR 6/4) gravelly loam, brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; hard, friable, moderately sticky and slightly plastic; common fine and very fine and few medium roots; common fine and very fine tubular and irregular pores; common fine calcium carbonate seams and coatings on rock fragments, 21 percent calcium carbonate equivalent; 30 percent gravel; violently effervescent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bk3—31 to 60 inches; pink (7.5YR 7/4) very gravelly loam, brown (7.5YR 5/4) moist; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; few very fine and fine roots; common fine and very fine tubular and irregular pores; weakly calcium carbonate cemented throughout; 28 percent calcium carbonate equivalent; 55 percent gravel; violently effervescent; moderately alkaline (pH 8.2).

Range in Characteristics

Depth to calcic horizon: 8 to 15 inches

Rock fragments: average 35 to 55 percent in the particle size control section but there can be less than 35 percent in any one horizon

A and Bw horizons

Hue: 5YR, 7.5YR

Value: 4 through 6 dry, 3 through 5 moist

Chroma: 3 or 4, dry or moist

Calcium carbonate equivalent: 3 to 10 percent

Texture: loam or fine sandy loam

Rock fragments: 35 to 55 percent gravel, 0 to 15 percent cobble

Bk horizons

Hue: 5YR, 7.5YR

Value: 5 through 7 dry, 4 through 6 moist

Chroma: 3 through 6, dry or moist

Calcium carbonate equivalent: 15 to 35 percent

Texture: loam or sandy loam

Rock fragments: 20 to 55 percent gravel, 0 to 15 percent cobble

Rock outcrop

Shoulders and escarpments consisting of fractured

sandy limestone and limy sandstone of the Kaibab Formation

172—Yumtheska-Rock outcrop complex, 0 to 2 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 6,200 to 7,000 feet (1,890 to 2,134 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 50 to 52 degrees F (10 to 11 degrees C)

Mean annual soil temperature: 52 to 54 degrees F (12 to 13 degrees C)

Frost-free period: 140 to 160 days

Map Unit Composition

Yumtheska and similar soils: 45 percent

Rock outcrop: 40 percent

Minor components: 15 percent

- Soils that have no accumulation of calcium carbonate in the profile
- Soils that have low amounts of organic matter in the profile
- Soils that have accumulation of clay in the profile
- Soils that are moderately deep or deep to bedrock

Properties and Qualities

Yumtheska soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Calciustolls

Geomorphic position: summits

Parent material: residuum weathered from limestone

Slope: 0 to 2 percent

Surface fragments: about 15 percent cobbles, about 20 percent gravel, about 15 percent stones

Depth to restrictive feature: 7 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 0.9

Shrink-swell potential: about 1.5 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Medium

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Limestone Upland (JUOS, PIED)
13-17" p.z.

Ecosystem site number: 035XF619AZ

Present native vegetation: Artemisia, Utah juniper, Colorado pinyon, Stansbury cliffrose, green Mormon tea

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau; 2,440 feet south of Papago Point; 36 degrees, 1 minute, 0 seconds north latitude; 111 degrees, 52 minutes, 56 seconds west longitude.

A—0 to 3 inches; brown (7.5YR 4/4) very stony loam; dark brown (7.5YR 3/3) moist; moderate thick platy structure; slightly hard, very friable, slightly sticky and slightly plastic; common very fine roots; common very fine vesicular and few fine irregular pores; 15 percent gravel, 15 percent cobble, and 15 percent stone; slightly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

Bk—3 to 12 inches; brown (7.5YR 4/4) very stony loam; dark brown (7.5YR 3/3) moist; moderate fine and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common fine and few medium roots; common fine tubular pores; common fine calcium carbonate nodules; thick calcium carbonate coats and pendants on the sides and undersides of rock fragments; 15 percent gravel, 15 percent cobble, and 15 percent stone; violently effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

R—12 inches; limestone bedrock.

Range in Characteristics

Rock fragments: average more than 35 percent in the particle size control section

Clay content: averages 18 to 25 percent in the particle size control section

Depth to bedrock: 7 to 20 inches

A horizon

Hue: 7.5YR, 10YR

Value: 3 through 5, dry or moist

Chroma: 2 or 3, dry or moist

Organic matter: averages 1 to 5 percent in the surface

Bk horizon(s)

Hue: 7.5YR, 10YR

Value: 3 through 7 dry, 3 through 5 moist

Chroma: 2 through 4, dry or moist

Calcium carbonate equivalent: 15 to 40 percent

Rock outcrop

Escarpmnts and outcrops of sandy limestone and limy sandstone of the Kaibab Formation

173—Yumtheska-Rock outcrop complex, 2 to 8 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,900 to 6,100 feet (1,798 to 1,860 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)

Mean annual soil temperature: 50 to 54 degrees F (11 to 13 degrees C)

Frost-free period: 135 to 150 days

Map Unit Composition

Yumtheska and similar soils: 70 percent

Rock outcrop: 15 percent

Minor components: 15 percent

- Natank very gravelly silt loam, 2 to 8 percent slopes
- Phizphre very gravelly loam, 8 to 15 percent slopes
- Soils that have a very cobbly or very stony surface phase
- Soils on steeper slopes

Properties and Qualities

Yumtheska soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Calciustolls

Geomorphic position: summits

Parent material: colluvium and/or residuum weathered from limestone and sandstone

Slope: 2 to 8 percent

Surface fragments: about 50 percent gravel

Depth to restrictive feature: 11 to 17 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 1.4

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: Medium

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Limestone Upland (JUOS, PIED) 13-17" p.z.

Ecosystem site number: 035XF619AZ

Present native vegetation: Artemisia, Utah juniper, Colorado pinyon, Stansbury cliffrose, green Mormon tea

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Shivwits Plateau; 1.39 miles northeast of Red Rock Spring, 35 degrees, 59 minutes, 11 seconds north latitude; 113 degrees, 37 minutes, 56 seconds west longitude.

A1—0 to 1 inch; very pale brown (10YR 6/3) very gravelly loam, brown (10YR 4/3) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and nonplastic; few very fine and fine roots; few very fine tubular pores; 50 percent gravel; violently effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

A2—1 to 5 inches; brown (10YR 5/3) very gravelly loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; soft, very friable, moderately sticky and nonplastic; common very fine and fine roots, common very fine and fine tubular pores; 50 percent gravel; violently effervescent; moderately alkaline (pH 8.4); clear smooth boundary.

Bk—5 to 13 inches; dark yellowish brown (10YR 4/4) very gravelly loam, dark brown (10YR 4/3) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and nonplastic; common very fine through coarse roots; common very fine and fine tubular pores; 70 percent gravel; moderately thick calcium carbonate coats and pendants on undersides of rock fragments; violently effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

R—17 inches; limestone bedrock.

Range in Characteristics

Rock fragments: average more than 35 percent in the particle size control section

Clay content: averages 18 to 25 percent in the particle size control section

Depth to bedrock: 11 to 17 inches

A horizon

Hue: 7.5YR, 10YR

Value: 3 through 5, dry or moist

Chroma: 2 or 3, dry or moist

Organic matter: averages 1 to 5 percent in the surface

Bk horizon(s)

Hue: 7.5YR, 10YR

Value: 3 through 7 dry, 3 through 5 moist

Chroma: 2 through 4, dry or moist

Calcium carbonate equivalent: 15 to 40 percent

Rock outcrop

Shoulders of ridges and hills

174—Yumtheska-Rock outcrop complex, 15 to 45 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,900 to 6,100 feet (1,798 to 1,860 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 48 to 52 degrees F (9 to 11 degrees C)

Mean annual soil temperature: 50 to 54 degrees F (11 to 13 degrees C)

Frost-free period: 135 to 150 days

Map Unit Composition

Yumtheska and similar soils: 65 percent

Rock outcrop: 25 percent

Minor components: 10 percent

- Phizphre very gravelly loam, 8 to 15 percent slopes
- Deep and very deep soils on toeslopes
- Soils that are subject to flooding
- Natank soils in concavities
- Soils that have a very cobbly or very stony surface phase

Properties and Qualities

Yumtheska soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Calciustolls

Geomorphic position: shoulders and sideslopes of hills and ridges

Parent material: colluvium and/or residuum weathered from limestone and sandstone

Slope: 15 to 45 percent

Surface fragments: about 10 percent cobbles, about 65 percent coarse gravel

Depth to restrictive feature: 7 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 1.4

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Limestone Slopes (PIED, JUOS) 13-17" p.z.

Ecosystem site number: 035XF613AZ

Present native vegetation: muttongrass, Artemisia, Stansbury cliffrose, Colorado pinyon, Utah juniper

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Shivwits Plateau; 3□

Range in Characteristics

Rock fragments: average more than 35 percent in the particle size control section

Clay content: averages 18 to 25 percent in the particle size control section

Depth to bedrock: 7 to 20 inches

A horizon

Hue: 7.5YR, 10YR

Value: 3 through 5, dry or moist

Chroma: 2 or 3, dry or moist

Organic matter: averages 1 to 5 percent in the surface

Bk horizon(s)

Hue: 7.5YR, 10YR

Value: 3 through 7 dry, 3 through 5 moist

Chroma: 2 through 4, dry or moist

Calcium carbonate equivalent: 15 to 40 percent

Rock outcrop

Rounded shoulders of hills and ridges

175—Yumtheska-Toqui-Rock outcrop complex, 2 to 8 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 5,000 to 6,600 feet (1,524 to 2,012 meters)

Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)

Mean annual air temperature: 52 to 54 degrees F (11 to 12 degrees C)

Mean annual soil temperature: 54 to 56 degrees F (13 to 14 degrees C)

Frost-free period: 120 to 160 days

Map Unit Composition

Yumtheska and similar soils: 40 percent

Toqui and similar soils: 30 percent

Rock outcrop: 15 percent

Minor components: 15 percent

- Soils that have no accumulations of calcium carbonate or clay in the profile
- Clayey soils that have more than 35 percent rock fragments in the profile
- Loamy soils that have low amounts of organic matter in the surface
- Soil that are moderately deep to bedrock

Properties and Qualities

Yumtheska soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Calciustolls

Geomorphic position: summits

Parent material: residuum weathered from limestone and sandstone

Slope: 2 to 8 percent

Surface fragments: about 5 percent cobbles, about 10 percent coarse gravel, about 5 percent stones

Depth to restrictive feature: 7 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 1.4

Shrink-swell potential: about 1.5 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: High

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Limestone Upland (JUOS, PIED) 13-17" p.z.

Ecosystem site number: 035XF619AZ

Present native vegetation: Artemisia, Utah juniper, Colorado pinyon, Stansbury cliffrose, green Mormon tea

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau; 990 feet west of Mather Point; 36 degrees, 3 minutes, 43 seconds north latitude; 112 degrees, 6 minutes, 38 seconds west longitude.

A—0 to 3 inches; dark brown (7.5YR 3/4) gravelly very fine sandy loam; dark brown (7.5YR 3/2) moist; weak thick platy structure parting to moderate very fine subangular blocky; soft, very friable, nonsticky and nonplastic; many very fine roots; common very fine irregular and few fine tubular pores; 10 percent gravel, 5 percent cobble, 5 percent stone; slightly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

Bw—3 to 7 inches; dark brown (7.5YR 3/4) gravelly loam; dark brown (7.5YR 3/3) moist; weak medium

subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and common fine roots; few fine tubular pores; 15 percent gravel, 5 percent cobble; strongly effervescent; moderately alkaline (pH 8.0); abrupt irregular boundary.

Bk1—7 to 14 inches; brown (7.5YR 4/4) very cobbly loam; dark brown (7.5YR 3/3) moist; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many very fine and fine and few medium roots; few fine tubular pores; common moderately thick calcium carbonate coatings on the undersides and sides of rock fragments; 10 percent gravel, 35 percent cobble, and 10 percent flagstone; violently effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

Bk2—14 to 19 inches; brown (7.5YR 4/4) very flaggy loam; dark brown (7.5YR 3/3) moist; moderate fine and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common fine and medium roots; few fine tubular pores; common moderately thick calcium carbonate coatings on the undersides and sides of rock fragments; 10 percent gravel, 45 percent flagstone; violently effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

R—19 inches; fractured limestone bedrock.

Range in Characteristics

Rock fragments: average more than 35 percent in the particle size control section

Clay content: averages 18 to 25 percent in the particle size control section

Depth to bedrock: 7 to 20 inches

A horizon

Hue: 7.5YR, 10YR

Value: 3 through 5, dry or moist

Chroma: 2 or 3, dry or moist

Organic matter: averages 1 to 5 percent in the surface

Bk horizon(s)

Hue: 7.5YR, 10YR

Value: 3 through 7 dry, 3 through 5 moist

Chroma: 2 through 4, dry or moist

Calcium carbonate equivalent: 15 to 40 percent

Toqui soils

Taxonomic classification: Clayey, smectitic, mesic Lithic Haplustalfs

Geomorphic position: summits

Parent material: residuum weathered from limestone

Slope: 2 to 8 percent

Surface fragments: about 5 percent stones, about 15 percent cobbles, about 5 percent coarse gravel

Depth to restrictive feature: 8 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.03 in/hr (very slow)

Available water capacity total inches: 1.0

Shrink-swell potential: about 7.5 LEP (high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: High

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Clay Loam Upland, Gravelly (PIED, JUOS) 13-17" p.z.

Ecosystem site number: 035XF611AZ

Present native vegetation: muttongrass, Utah juniper, Wyoming big sagebrush, blue grama, Colorado pinyon

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau; 810 feet south of Mather Point; 36 degrees, 3 minutes, 34 seconds north latitude; 112 degrees, 6 minutes, 26 seconds west longitude.

A—0 to 2 inches; brown (7.5YR 4/4) stony loam; dark brown (7.5YR 3/3) moist; moderate thick platy structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and few fine roots; few fine tubular pores; 5 percent gravel, 5 percent cobble, and 5 percent stone; noneffervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

Bw—2 to 4 inches; dark brown (7.5YR 3/4) stony clay loam; dark brown (7.5YR 3/3) moist; moderate medium subangular blocky structure; hard, friable, moderately sticky and moderately plastic; common fine roots; few fine tubular pores; 5 percent gravel, 5 percent cobble, and 5 percent stone; noneffervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

Bt—4 to 8 inches; dark brown (7.5YR 3/4) stony silty clay; dark brown (7.5YR 3/3) moist; strong medium subangular blocky structure; hard, friable, moderately sticky and moderately plastic; common fine and medium roots; few fine tubular pores; common faint clay films on faces of peds; 15 percent gravel, 5 percent cobble, and 5 percent stone; noneffervescent; moderately alkaline (pH 8.0); abrupt irregular boundary.

R—8 inches; cherty limestone bedrock.

Range in Characteristics

Depth to bedrock: 8 to 20 inches

A horizon

Hue: 7.5YR, 10YR
 Value: 3 through 5 dry, 3 or 4 moist
 Chroma: 3 through 6 dry, 2 through 4 moist
 Reaction: slightly acid to moderately alkaline

Bt horizon

Hue: 5YR, 7.5YR
 Value: 3 through 5 dry, 3 or 4 moist
 Chroma: 3 through 6, dry or moist
 Rock fragments: averages 0 to 35 percent, mostly gravel
 Clay content: averages 35 to 50 percent, may be less in some horizons

Some pedons may have Bk or Btk horizons.

Rock outcrop

Escarments and outcrops

176—Yumtheska-Toqui-Rock outcrop complex, 15 to 40 percent slopes

Map Unit Setting

Landform: plateau
Elevation: 6,200 to 6,600 feet (1,890 to 2,012 meters)
Mean annual precipitation: 14 to 18 inches (356 to 457 millimeters)
Mean annual air temperature: 50 to 52 degrees F (10 to 11 degrees C)
Mean annual soil temperature: 52 to 54 degrees F (12 to 13 degrees C)
Frost-free period: 120 to 160 days

Map Unit Composition

Yumtheska and similar soils: 45 percent
 Toqui and similar soils: 30 percent
 Rock outcrop: 15 percent
 Minor components: 10 percent

- Soils that have no accumulation of calcium carbonate in the profile
- Soils that have low amounts of organic matter in the profile
- Soils in drainageways that are subject to occasional flooding

Properties and Qualities**Yumtheska soils**

Taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Lithic Calciustolls
Geomorphic position: summits

Parent material: residuum weathered from limestone and sandstone

Slope: 15 to 40 percent

Surface fragments: about 5 percent stones, about 5 percent cobbles, about 20 percent gravel

Depth to restrictive feature: 7 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 1.30 in/hr (moderate)

Available water capacity total inches: 1.1

Shrink-swell potential: about 1.5 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Limestone Slopes (PIED, JUOS) 13-17" p.z.

Ecosystem site number: 035XF613AZ

Present native vegetation: muttongrass, Artemisia, Stansbury cliffrose, Colorado pinyon, Utah juniper

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the Coconino Plateau; 912 feet south of Hermits Rest; 36 degrees, 3 minutes, 34 seconds north latitude; 112 degrees, 12 minutes, 38 seconds west longitude.

A—0 to 3 inches; brown (10YR 4/3) cobbly loam; dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and fine roots; common very fine irregular and few fine tubular pores; 15 percent gravel, 10 percent cobble, and 5 percent stone; noneffervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

Bk—3 to 11 inches; brown (10YR 4/3) extremely gravelly loam; dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine and medium roots; common fine tubular pores; many thick calcium carbonate coats and pendants on rock fragments; 50 percent gravel, 15 percent cobble; violently effervescent; moderately alkaline (pH 8.2); abrupt irregular boundary.

R—11 inches; fractured limestone bedrock.

Range in Characteristics

Rock fragments: average more than 35 percent in the particle size control section

Clay content: averages 18 to 20 percent in the particle size control section

Depth to bedrock: 7 to 20 inches

A horizon

Hue: 7.5YR, 10YR

Value: 3 through 5, dry or moist

Chroma: 2 or 3, dry or moist

Organic matter: averages 1 to 5 percent in the surface horizon

Bk horizon(s)

Hue: 7.5YR, 10YR

Value: 3 through 7 dry, 3 through 5 moist

Chroma: 2 through 4, dry or moist

Calcium carbonate equivalent: 15 to 40 percent

Toqui soils

Taxonomic classification: Clayey, smectitic, mesic
Lithic Haplustalfs

Geomorphic position: summits

Parent material: colluvium derived from limestone and sandstone

Slope: 15 to 40 percent

Surface fragments: about 65 percent gravel, about 5 percent cobbles

Depth to restrictive feature: 8 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.03 in/hr (very slow)

Available water capacity total inches: 1.2

Shrink-swell potential: about 7.5 LEP (high)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: very high

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-6

Ecological site name: Limestone Slopes (PIED, JUOS)
13-17" p.z.

Ecosystem site number: 035XF613AZ

Present native vegetation: muttongrass, Artemisia,
Stansbury cliffrose, Colorado pinyon, Utah juniper

Land capability (nonirrigated): 6c

Taxonomic Unit Description

Type Location: On the South Rim, 36 degrees 2 minutes 16 seconds north latitude, 111 degrees, 47 minutes 59 seconds south longitude.

A—0 to 1 inch; brown (10YR 4/3) very gravelly loam; very dark brown (10YR 2/2) moist; moderate fine

subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many very fine irregular pores; 45 percent gravel; noneffervescent; slightly acid (pH 6.2); abrupt smooth boundary.

Bw—1 to 7 inches; brown (7.5YR 4/3) very gravelly clay loam; dark brown (7.5YR 3/3) moist; moderate medium subangular blocky structure; slightly hard, friable, very sticky and very plastic; many very fine and fine and few medium and coarse roots; few fine tubular pores; few faint clay films lining pores; 40 percent gravel; noneffervescent; neutral (pH 6.6); abrupt smooth boundary.

Bt—7 to 12 inches; dark brown (7.YR 3/3) gravelly silty clay; dark brown (7.5YR 3/3) moist; moderate medium subangular blocky structure; hard, firm, very sticky and very plastic; common very fine through coarse roots; few fine tubular pores; common distinct clay films lining pores and on faces of peds; 25 percent gravel; noneffervescent; slightly acid (pH 6.2); abrupt irregular boundary.

R—12 inches; sandstone bedrock.

Range in Characteristics

Depth to bedrock: 8 to 20 inches

A horizon

Hue: 7.5YR, 10YR

Value: 3 through 5 dry, 3 or 4 moist

Chroma: 3 through 6 dry, 2 through 4 moist

Reaction: slightly acid to slightly alkaline

Bt horizon

Hue: 5YR, 7.5YR

Value: 3 through 5 dry, 3 or 4 moist

Chroma: 3 through 6, dry or moist

Rock fragments: average 0 to 35 percent, mostly gravel

Clay content: averages 35 to 50 percent, may be less in some horizons

Some pedons may have Bk or Btk horizons.

Rock outcrop

Ridges and escarpments

177—Zibate family, 2 to 8 percent slopes

Map Unit Setting

Landform: plateau

Elevation: 3,500 to 4,500 feet (1,067 to 1,372 meters)

Mean annual precipitation: 6 to 10 inches (152 to 254 millimeters)

Mean annual air temperature: 57 to 63 degrees F (14 to 17 degrees C)

Mean annual soil temperature: 59 to 65 degrees F (16 to 19 degrees C)

Frost-free period: 200 to 240 days

Map Unit Composition

Zibate family and similar soils: 90 percent

Minor components: 10 percent

- Soils that have no accumulation of calcium carbonate in the profile
- Soils that are deep or very deep to bedrock

Properties and Qualities

Zibate family soils

Taxonomic classification: Loamy-skeletal, mixed, superactive, thermic Lithic Haplargids

Geomorphic position: summits and side slopes of flat to very steep pediments

Parent material: residuum weathered from arkose

Slope: 2 to 8 percent

Surface fragments: about 5 percent cobbles, about 45 percent gravel

Depth to restrictive feature: 6 to 20 inches to bedrock (lithic)

Drainage class: Well drained

Permeability: about 0.4 in/hr (moderately slow)

Available water capacity total inches: 0.7

Shrink-swell potential: about 1.0 LEP (low)

Flooding hazard: None

Seasonal water table minimum depth: greater than 6 feet

Runoff class: High

Hydrologic group: D

Major Land Resource Area: 35

Land Resource Unit: 35-5

Ecological site name: Limy Upland, Shallow 6-10" p.z.

Ecosystem site number: 035XE519AZ

Present native vegetation: blackbrush, ephedra, Opuntia, banana yucca

Land capability (nonirrigated): 7c

Taxonomic Unit Description

Type Location: On the Tonto Platform; 3,194 feet northeast of Garden Creek; 36 degrees, 5 minutes, 15

seconds north latitude; 112 degrees, 6 minutes, 9 seconds west longitude.

A—0 to 2 inches; strong brown (7.5YR 4/6) very gravelly loam; brown (7.5YR 4/4) moist; weak thin platy structure; soft, very friable, slightly sticky and slightly plastic; few very fine roots; many very fine vesicular pores; 50 percent gravel; noneffervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

Bt—2 to 6 inches; reddish brown (5YR 4/4) very gravelly clay loam; reddish brown (5YR 4/4) moist; moderate fine subangular blocky structure parting to strong very fine angular blocky; hard, friable, very sticky and very plastic; common very fine through medium roots; common very fine tubular pores; common faint clay films lining pores; 40 percent gravel; noneffervescent; moderately alkaline (pH 8.0); clear smooth boundary.

Btk—6 to 9 inches; yellowish red (5YR 4/6) extremely gravelly silty clay loam; reddish brown (5YR 4/4) moist; moderate fine subangular blocky structure parting to strong very fine angular blocky; hard, friable, very sticky and very plastic; few very fine and fine roots; common very fine tubular pores; common faint clay films on faces of peds; 20 percent soft filaments and masses of calcium carbonate; common moderately thick calcium carbonate coats and pendants on rock fragments; 60 percent gravel; noneffervescent; moderately alkaline (pH 8.0); abrupt irregular boundary.

R—9 inches; Tapeats sandstone bedrock.

Range in Characteristics

Depth to bedrock: 6 to 20 inches

Effervescence: noneffervescent to strongly effervescent

A horizon

Hue: 10YR, 7.5YR

Value: 3 through 6 dry, 3 through 5 moist

Chroma: 3 or 4, dry or moist

Bt horizon

Hue: 5YR, 10YR, 7.5YR

Value: 3 through 5, dry or moist

Chroma: 3 through 6, dry or moist

Clay content: 18 to 35 percent

Rock fragments: 35 to 85 percent

Reaction: mildly alkaline or moderately alkaline.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help to prevent soil-related failures in land uses.

In preparing a soil survey, soil scientists collect extensive field data about the nature and behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for forestland, as sites for parks and other recreational facilities, and as wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Interpretive Ratings

The interpretive tables in this survey rate the soils in the survey area for recreational uses. The recreational table identifies the limitations that affect specified uses and indicate the severity of those limitations. The ratings in these tables are both verbal and numerical.

Rating Class Terms

Rating classes are expressed in the tables in terms that indicate the extent to which the soils are limited by all of the soil features that affect a specified use or in terms that indicate the suitability of the soils for the use. Thus, the tables may show limitation classes or suitability classes. Terms for the limitation classes are *not limited*, *slightly limited*, *somewhat limited*, and *very*

limited. The suitability ratings are expressed as *well suited*, *moderately well suited*, *poorly suited*, and *unsuited* or as *good*, *fair*, and *poor*.

Numerical Ratings

Numerical ratings in the tables indicate the relative severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.00 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use and the point at which the soil feature is not a limitation. The higher number indicates a higher limitation. The limitations appear in order from the most limiting to the least limiting. Thus, if more than one limitation is identified, the most severe limitation is listed first and the least severe one is listed last.

Rangeland and Woodland

Art Meen, Soil Conservationist, Natural Resources Conservation Service, prepared this section.

The Grand Canyon and Lake Mead Soil Survey encompasses a part of the eastern edge of the Mohave Desert and a significant portion of the Colorado Plateau. Average annual precipitation in the Soil Survey area varies from as low as 3 inches west of the Grand Wash Cliffs to more than 30 inches on the North Kaibab Plateau. Mean annual air and soil temperatures range from hyperthermic (70-76 degrees F) at the lowest elevations of the Mohave Desert, to frigid (36-44 degrees F) at the highest elevations of the Colorado Plateau.

Winter-summer moisture ratios are typically 70:30 on the west side of this soil survey area, and shift to 60:40 on the east side. Summer rains fall from June through September; they originate from moisture that comes up from Mexico and are convective, usually brief, intense thunderstorms. Cool-season moisture from October through May tends to be frontal: it originates in the Pacific and the Gulf of California and falls in widespread storms with longer duration and lower intensity. Snow is very rare at the lowest elevations and seldom lasts more than 1 day. The

highest elevations can receive snow in almost any month, and snowpack is a significant factor for about 8 months.

Soils provide the foundation for the NRCS Land Classification System. Soils that have the potential to produce similar plant communities are grouped into ecological sites, wildlife habitat types, and other interpretive groups that are useful to land managers. Soil interpretations are developed to provide information about potentials and limitations for various uses.

The NRCS Range and Pasture Handbook defines rangeland as “a kind of land on which the historic climax vegetation was predominantly grasses, grass-like plants, forbs or shrubs” (USDA, 1997). Rangelands include natural grasslands, savannas, most deserts, tundra, alpine plant communities, coastal and freshwater marshes, and wet meadows.

Forest land is separated from rangeland primarily on the basis of the natural ability or potential of an ecological site to produce a tree canopy cover of 25 percent or greater. Forest lands that historically had widely-spaced trees, such as ponderosa pine and pinyon-juniper forests, normally produce a crop of forage each year under the canopy.

Ecological Sites

The National Range and Pasture Handbook defines an ecological site as “a distinctive kind of land with specific physical characteristics, that differs from other kinds of land in its ability to produce a distinctive kind and amount of vegetation, and in its response to management” (USDA, 1997).

An ecological site is the product of all the environmental factors responsible for its development, and it has a set of key traits that are included in the ecological site description. Ecological sites have characteristic soils that have developed over time throughout the soil development process. The factors of soil development are parent material, climate, living organisms, topography or landscape position, and time. These factors lead to soil development or degradation through the processes of loss, addition, translocation, and transformation.

Soils with like properties that produce and support a characteristic native plant community are grouped into the same ecological site. An ecological site is recognized and described on the basis of the attributes that differentiate it from other sites in its ability to produce and support a characteristic plant community.

An ecological site has a characteristic hydrology, particularly infiltration and runoff, that has developed over time. The development of the hydrology is

influenced by development of the soil and plant community.

An ecological site has evolved a characteristic plant community that is distinctive in kind (cool season, warm season, grassland, shrub-grass, sedge meadow), structure (forest, grassland, shrubland), and amount of vegetation. The development of the vegetation, the soil, and the hydrology are all interrelated. Each is influenced by the others and influences the development of the others. The plant community on an ecological site is typified by an association of species that differs from that of other ecological sites in the kind and/or proportion of species, or in total production.

Most ecological sites evolved with a characteristic kind of herbivory (types and numbers of herbivores, seasons of use, intensity of use). Herbivory directly influences the vegetation and soil, both of which influence the hydrology. An ecological site also evolved with a typical fire regime. Fire frequency and intensity contribute to the kind of plant community found on the site.

Rangeland

Table 2 shows, for each soil that supports vegetation suitable for grazing, the ecological site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. An explanation of the column headings in table 2 follows.

Total dry-weight production is the amount of vegetation that can be expected to grow annually in a well managed area that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture. Yields are adjusted to a common percent of air-dry moisture content.

Characteristic vegetation—the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil—is listed by common name. Under *rangeland composition*, the expected percentage of the total annual production is given for each species

making up the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

Forest Productivity

In table 3, the *potential productivity of common trees* on a soil is expressed as a site index and as a volume number. The *site index* is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that forest managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability. More detailed information regarding site index is available in the National Forestry Manual, which is available in local offices of the Natural Resources Conservation Service or on the Internet.

The *volume of wood fiber*, a number, is the yield likely to be produced by the most important tree species. This number, expressed as cubic feet per acre per year and calculated at the age of culmination of the mean annual increment (CMAI), indicates the amount of fiber produced in a fully stocked, even-aged, unmanaged stand.

Woodland Understory Vegetation

Understory vegetation consists of grasses, forbs, shrubs, and other plants. If well managed, some woodland can produce enough understory vegetation to support grazing of livestock or wildlife, or both, without damage to the trees.

The quantity and quality of understory vegetation vary with the kind of soil, the age and kind of trees in the canopy, the density of the canopy, and the depth and condition of the litter. The density of the canopy determines the amount of light that understory plants receive.

Table 2 shows, for each soil suitable for woodland, the potential for producing understory vegetation. The total production of understory vegetation includes the herbaceous plants and the leaves, twigs, and fruit of woody plants up to a height of 4.5 feet. It is expressed in pounds per acre of air-dry vegetation in favorable, normal, and unfavorable years. In a favorable year, soil moisture is above average during the optimum part of the growing season; in a normal year, soil moisture is average; and in an unfavorable year, it is below average.

The table also lists the common names of the

characteristic vegetation on each soil and the *composition*, by percentage of air-dry weight, of each kind of plant. The table shows the kind and percentage of understory plants expected under a canopy density that is most nearly typical of woodland in which the production of wood crops is highest.

Recreation

The soils of the survey area are rated in table 4 according to limitations that affect their suitability for recreation. The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect the recreational uses. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Slightly limited* indicates that the soil has features that are favorable for the specified use. The limitations are minor and can be easily overcome. Good performance and low maintenance can be expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.00 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

The ratings in the table are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation also are important. Soils that are subject to flooding are limited for recreational uses by the duration and intensity of flooding and the season when flooding occurs. In planning recreational facilities, onsite assessment of

the height, duration, intensity, and frequency of flooding is essential.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The ratings are based on the soil properties that affect the ease of developing camp areas and the performance of the areas after development. Slope, stoniness, and depth to bedrock or a cemented pan are the main concerns affecting the development of camp areas.

The soil properties that affect the performance of the areas after development are those that influence trafficability and promote the growth of vegetation, especially in heavily used areas. For good trafficability, the surface of camp areas should absorb rainfall readily, remain firm under heavy foot traffic, and not be dusty when dry. The soil properties that influence trafficability are texture of the surface layer, depth to a water table, ponding, flooding, permeability, and large stones. The soil properties that affect the growth of plants are depth to bedrock or a cemented pan, permeability, and toxic substances in the soil.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The ratings are based on the soil properties that affect the ease of developing picnic areas and that influence trafficability and the growth of vegetation after development. Slope and stoniness are the main concerns affecting the development of picnic areas. For good trafficability, the surface of picnic areas should absorb rainfall readily, remain firm under heavy foot traffic, and not be dusty when dry. The soil properties that influence trafficability are texture of the surface layer, depth to a water table, ponding, flooding, permeability, and large stones. The soil properties that affect the growth of plants are depth to bedrock or a cemented pan, permeability, and toxic substances in the soil.

Paths and trails for hiking and horseback riding should require little or no slope modification through cutting and filling. The ratings are based on the soil properties that affect trafficability and erodibility. These properties are stoniness, depth to a water table, ponding, flooding, slope, and texture of the surface layer.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. Soil properties are ascertained by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help to characterize key soils.

The estimates of soil properties are shown in tables 5, 6, 7, 8, and 9. They include engineering index properties, physical and chemical properties, and pertinent soil and water features.

Engineering Index Properties

Table 5 gives the engineering classifications and the range of index properties for the layers of each soil in the survey area.

Depth to the upper and lower boundaries of each layer is indicated.

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (ASTM, 1998) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO, 1998).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to particle-size

distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of particle-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

Rock fragments larger than 10 inches in diameter and 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and plasticity index (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of particle-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is generally omitted in the table.

Physical Properties

Table 6 shows estimates of some physical characteristics and features that affect soil behavior. These estimates are given for the layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Depth to the upper and lower boundaries of each layer is indicated.

Particle size is the effective diameter of a soil particle as measured by sedimentation, sieving, or micrometric methods. Particle sizes are expressed as classes with specific effective diameter class limits. The broad classes are sand, silt, and clay, ranging from the larger to the smaller.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In table 6, the estimated clay content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of sand, silt, and clay affects the physical behavior of a soil. Particle size is important for engineering and agronomic interpretations, for determination of soil hydrologic qualities, and for soil classification.

The amount and kind of clay affect the fertility and physical condition of the soil and the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving.

The amount and kind of clay in a soil also affect tillage and earthmoving.

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the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and permeability. Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor Kw indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.

Erosion factor Kf indicates the erodibility of the fine-earth fraction, or the material less than 2 millimeters in size.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their susceptibility to wind erosion in cultivated areas. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible. The groups are as follows:

1. Coarse sands, sands, fine sands, and very fine sands.
2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, ash material, and sapric soil material.
3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams.
- 4L. Calcareous loams, silt loams, clay loams, and silty clay loams.
4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay.
5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material.
6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay.
7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material.
8. Soils that are not subject to wind erosion because of coarse fragments on the surface or because of surface wetness.

Wind erodibility index is a numerical value indicating the susceptibility of soil to wind erosion, or the tons per acre per year that can be expected to be lost to wind erosion. There is a close correlation between wind erosion and the texture of the surface layer, the size

and durability of surface clods, rock fragments, organic matter, and a calcareous reaction. Soil moisture and frozen soil layers also influence wind erosion.

Chemical Properties

Table 7 shows estimates of some chemical characteristics and features that affect soil behavior. These estimates are given for the layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Depth to the upper and lower boundaries of each layer is indicated.

Cation-exchange capacity is the total amount of extractable bases that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. Soils having a low cation-exchange capacity hold fewer cations and may require more frequent applications of fertilizer than soils having a high cation-exchange capacity. The ability to retain cations reduces the hazard of ground-water pollution.

Soil reaction is a measure of acidity or alkalinity. The pH of each soil horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Calcium carbonate equivalent is the percent of carbonates, by weight, in the fraction of the soil less than 2 millimeters in size. The availability of plant nutrients is influenced by the amount of carbonates in the soil. Incorporating nitrogen fertilizer into calcareous soils helps to prevent nitrite accumulation and ammonium-N volatilization.

Gypsum is expressed as a percent, by weight, of hydrated calcium sulfates in the fraction of the soil less than 20 millimeters in size. Gypsum is partially soluble in water. Soils that have a high content of gypsum may collapse if the gypsum is removed by percolating water.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used

as construction material, and the potential of the soil to corrode metal and concrete.

Sodium adsorption ratio (SAR) is a measure of the amount of sodium (Na) relative to calcium (Ca) and magnesium (Mg) in the water extract from saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. Soils that have SAR values of 13 or more may be characterized by an increased dispersion of organic matter and clay particles, reduced permeability and aeration, and a general degradation of soil structure.

Soil Features

Table 8 gives estimates of various soil features. The estimates are used in land use planning that involves engineering considerations.

A *restrictive layer* is a nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impede the movement of water and air through the soil or that restrict roots or otherwise provide an unfavorable root environment. Examples are bedrock, cemented layers, dense layers, and frozen layers. The table indicates the hardness of the restrictive layer, which significantly affects the ease of excavation.

Depth to top is the vertical distance from the soil surface to the upper boundary of the restrictive layer.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence generally results from either desiccation and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. The table shows the expected initial subsidence, which usually is a result of drainage, and total subsidence, which results from a combination of factors.

Potential for frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during

thawing cause damage to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel or concrete in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel or concrete in installations that are entirely within one kind of soil or within one soil layer. For *uncoated steel*, the risk of corrosion, expressed as low, moderate, or high, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract. For *concrete*, the risk of corrosion also is expressed as low, moderate, or high. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Water Features

Table 9 gives estimates of various water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas.

The *months* in the table indicate the portion of the year in which the feature is most likely to be a concern.

Water table refers to a saturated zone in the soil. Table 9 indicates, by month, depth to the top (*upper limit*) and base (*lower limit*) of the saturated zone in most years. Estimates of the upper and lower limits are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors or mottles (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

Ponding is standing water in a closed depression. Unless a drainage system is installed, the water is removed only by percolation, transpiration, or evaporation. Table 9 indicates *surface water depth* and the *duration* and *frequency* of ponding. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 to 30 days, and *very long* if more than 30 days. Frequency is expressed as none, rare, occasional, and frequent. *None* means that ponding is not probable; *rare* that it is unlikely but possible under unusual weather conditions (the chance of ponding is nearly 0 percent to 5 percent in any year); *occasional* that it occurs, on the average, once or less in 2 years (the chance of ponding is 5 to 50 percent in any year); and *frequent* that it occurs, on the average, more than once in 2 years (the chance of ponding is more than 50 percent in any year).

Flooding is the temporary inundation of an area caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

Duration and *frequency* are estimated. Duration is expressed as *extremely brief* if 0.1 hour to 4 hours, *very brief* if 4 hours to 2 days, *brief* if 2 to 7 days, *long* if 7 to 30 days, and *very long* if more than 30 days. Frequency is expressed as none, very rare, rare, occasional, frequent, and very frequent. *None* means that flooding is not probable; *very rare* that it is very unlikely but possible under extremely unusual weather conditions (the chance of flooding is less than 1 percent in any year); *rare* that it is unlikely but possible under unusual weather conditions (the chance of flooding is 1 to 5 percent in any year); *occasional* that it occurs infrequently under normal weather conditions (the chance of flooding is 5 to 50 percent in any year); *frequent* that it is likely to occur often under normal weather conditions (the chance of flooding is more than 50 percent in any year but is less than 50 percent in all months in any year); and *very frequent* that it is likely to occur very often under normal weather conditions (the chance of flooding is more than 50 percent in all months of any year).

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and little or no horizon development.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

The system of soil classification used by the National Cooperative Soil Survey has six categories (USDA, 1998 and 1999). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 10 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Twelve soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending *inso*. An example is Alfisols.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Ustalfs (*ust*, meaning burnt or dry climate, plus *alf*, from Alfisols).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; type of saturation; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Paleustalfs (*Pale*, meaning old development, plus *ustalf*, the suborder of the Alfisols that has a ustic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic subgroup is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other members of the great group. Extragrades are members of the great group that do not fit the concept of the typic subgroup. Each subgroup is identified by the name of a great group and by a suffix that indicates a property of the soil. An example is Paleustalf, typic, *dry* (the *dry* indicates a dry climate).

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series name is used for brevity only and always includes the word "family," for example Firo family.

Some map units have components named at higher taxon levels such as Lithic Torriorthents or even higher such as Orthents. In the canyon interior the components are named as higher level taxons due to the extreme inaccessibility not allowing sufficient

documentation to be gathered to warrant more detail. For these units horizon data is not given.

Some map units outside the canyon interior have higher taxon units but do have horizon data. In these cases adequate documentation could be gathered but soil variability was so great as to require classification at a higher taxon.

Formation of the Soils

Processes of Soil Formation

Soils are dynamic, natural bodies on the earth's surface that are capable of supporting terrestrial plants. They are composed of mineral and organic constituents, dilute solutions, gaseous mixtures, and microorganisms. Soils are dynamic in that they exist as the result of a combination of processes occurring in the environment and they respond to changes in the environment. Some responses are immediate, such as increased water content and microbial activity after a rain. Some responses, such as the development of soil morphology, are only detectable after a long period of time.

Differences in soil morphology are expressed by differences in the horizontal layers, or horizons, within soils (USDA, 1993). Pedogenic soil horizons form primarily as the result of eluviation and illuviation. Eluviation is a process whereby materials are leached out of a horizon by infiltrating water. Illuviation is the accumulation of materials below the surface as the result of deposition from the leaching water. The soil materials on and near the surface are the most susceptible to being leached by water. These horizons lose clay, calcium carbonate, and other materials that were originally in the sediment at the time of deposition.

If conditions are suitable, organic matter accumulates in surface horizons as the result of plant growth and decomposition. Calcareous dust and other materials are deposited on the soil surface by wind or are leached out of the surface horizons to accumulate at lower levels of the soil profile. As a result, clay, calcium carbonate, and other materials accumulate in the subsoil in much higher concentrations than were present in the original sediment. These zones of leaching and accumulation define pedogenic soil horizons and determine how the soil is classified. Important pedogenic soil horizons are defined in the glossary.

Factors of Soil Formation

There are five environmental factors that affect soil formation (Jenny, 1941). These factors are parent

material, climate, living organisms, topography, and time. Tremendous diversity exists in soil morphology as a result of unique combinations of these soil forming factors. Over time, soil horizons constantly form or change in response to these environmental factors. All the soil forming factors are connected, and no single factor alone completely determines a soil property. Each factor is discussed individually in the following sections.

Parent Material

Parent material is the mineral and organic material in which soils form. It can be derived in place from weathered bedrock or transported by wind, water, or gravity. The minerals and salts in the parent material determine many chemical and physical characteristics of the resulting soil. The size and distribution of soil particles also may determine the rate and degree of weathering.

Residuum

Residuum is the unconsolidated mineral material that accumulates in place as bedrock disintegrates. The kind of rock from which the residuum weathers greatly determines the properties and characteristics of a soil that forms in it. Both the mineralogy and the rock fabric greatly influence the rate of weathering and the resulting soil chemistry. For example, residuum derived from sandstone high in quartz usually contains large amounts of sand. Sandstone high in feldspars may weather into a soil that has a large amount of clay. Parent materials derived from shale may have large amounts of clay and low amounts of sand. Many types of shale may contain large amounts of sodium, gypsum, or sulfur-bearing minerals. Basalt rocks usually form soils that contain large amounts of clay. Limestone rocks form residuum that has variable amounts of clay, depending on the composition and fabric of the rock.

In the Grand Canyon Area soil survey, many soils formed from residuum. The primary formation exposed on the surface of almost all of the plateaus is the Kaibab Formation. Thus, the parent material is Kaibab Formation residuum. However, the Kaibab Formation is



Figure 20.—The Tonto Platform where the Tapeats Sandstone in the foreground is flat enough to allow soil formation in residuum.

extremely variable, horizontally and vertically (Beus and Morales, 1990). It is composed of two members. The uppermost one is the Harrisburg member. The lower one is called the Fossil Mountain member. The Harrisburg member is exposed on the South and North Rims. It is composed mostly of sandstone, dolostone, chert and limestone.

On the Coconino Plateau the beds are fairly thin (10 to 20 feet thick). They dip slightly to the southwest. As topography changes because of erosion, different beds occur at different elevations. Each bed has different weathering characteristics that result in different soil types as well as different vegetative ecosystems. For example, the Pinntank and Retsover soils are moderately deep soils that have high clay content. They formed from an easily weatherable sandstone bed in the Harrisburg member. These soils support stands of ponderosa pine woodlands because they are deep enough to hold sufficient water for big trees. In contrast, the Yumtheska soils are very shallow and have low clay content. These soils have formed in limestone and dolostone beds that are resistant to

weathering, and they support stands of low-producing pinyon and juniper woodlands. The Toqui soils are also shallow, but they have moderate amounts of clay in the profile. These soils seem to be associated with large (200 to 500 feet in diameter) lenticular bodies of chert with a ferruginous sandy matrix. These bodies were once depressions on a limy Permian sea shore where shells, corals, and other dead marine animals were deposited. They eventually were buried by other marine materials and became silicified and fossilized as they were being lithified. Apparently, because of their higher content of silica and greater porosity, they are more prone to clay formation than the surrounding limestone. These soils also carry pinyon and juniper woodlands but the trees are larger and more productive because the clay provides a higher water holding capacity. The Tovar and Pocomate soils are also common on the Coconino Plateau and have intermediate characteristics of the Pinntank and Yumtheska soils.

On the Coconino Plateau between Grandview Point and the Great Thumb Mesa, the vegetation changes

from pinyon/juniper woodland to Wyoming sagebrush. This change is primarily the result of lower elevations and less precipitation; however, it is also influenced by sedimentary rocks from the Fossil Mountain member. These soils are mostly less than 20 inches deep to bedrock. Some of them contain clay accumulations. Some of the soils contain materials cemented by calcium carbonate having petrcocalcic horizons. These are the Curhollow family, Puertecito family, Wodomont family, and Topocoba family soils. The soils and vegetation on this part of the South Rim are similar to the soils on Cape Solitude, Kanab Point, SB Point, Tuckup Point, Whitmore Point, Parashant Point, and the extreme southern end of Kelley Point.

The soils on Twin Point—the Natank, Disterheff, Binsin, and Bilburc soils—are rather unusual. They are deep and moderately deep to limestone bedrock. They contain high amounts of red clay, small amounts of rock fragments, and calcium carbonate. The soil surface is covered by a large quantity of gravel
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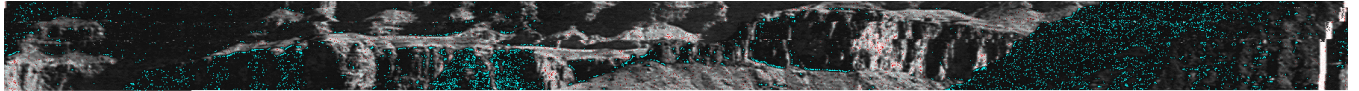


Figure 22.—Pleistocene Age alluvium deposited on high stream terraces near Furnace Flats.

The Tonto Platform consists of exposures of Tapeats Sandstone and Bright Angel Shale (fig. 20). The platform is flat enough for erosion to be minimal, and residuum is the dominant parent material. The Tapeats Sandstone is coarse grained and high in feldspars that readily form clays upon weathering. The soils are shallow to bedrock and have well formed argillic horizons. A low slope is required, however, because the sandstone is very erosive and crumbles into large blocks when slopes exceed 15 percent. These are the Zibate family soils.

The Bright Angel Shale was deposited conformably on the Tapeats Sandstone. There are thick zones of transition with stringers and interfingering of sandstone in the shale. On the east side of the survey area, the presence of glauconite gives the shale a greenish color (Beus and Morales, 1990). The Bright Angel shale has a blocky, chunky structure and a silty clay texture. On the west side of the survey area, it is very platy and very micaceous.

The green chunky variety is conducive to plant growth, whereas the platy micaceous variety is not. The plates are coherent and horizontally interlocking to such a high degree that plant roots cannot penetrate between them. In areas where, for unknown reasons, the micaceous plates are vertical, plant roots can penetrate the soil. Plant growth thus

follows a circular or polygonal distribution on the micaceous shale.

Soil formation in the Bright Angel Shale is minimal, even at low slopes, because of the extremely erosive nature of both kinds of shale. However, most pedons have some authigenic clay formation in the profile even though they do not quite qualify as argillic horizons. The Garr family soil occurs in this area.

The Esplanade is a broad bench where the Esplanade Sandstone is exposed. The Esplanade sandstone is not conducive to soil formation, and soils here are mostly Lithic Torriorthents. It is dense, compact sandstone that weathers into large boulders. The size of the sand particles composing the sandstone makes it very susceptible to wind erosion, and sand weathered from the rock is easily blown away. Soils only form in depressions and in other areas protected by vegetation. If soils become stabilized long enough, small amounts of calcium carbonate will begin to accumulate near the bottom of the soil profile.

The Esplanade Sandstone contains a small amount of calcium carbonate. However, the proportion increases as one moves west. On the Sanup Plateau, this formation has enough calcium carbonate to qualify as limestone and is called the Pakoon Limestone (Beus and Morales, 1990). The soils here are mostly

shallow, but in large depressions they are deep because sandy materials from the surrounding areas have washed into them.

Alluvium

Alluvium is unconsolidated sediment deposited by water. These materials include deposits made by rivers, creeks, intermittent streams, and materials at the base of mountains, forming alluvial fans, fan terraces, and bajadas.

The beaches along the river corridor are the most common example of alluvium in the survey area (fig. 21). Spring floods have deposited new sediment containing not only sand but fines as well. These finer particles contribute significantly to physical stability of the terraces and have a higher degree of soil fertility.

In some areas, alluvium occurs high above the river corridor. These very old sediments are thought to have been deposited in the Pleistocene (fig. 22). The soils formed in this alluvium are old and stable enough to have argillic horizons and accumulations of calcium carbonate in the profile.

Alluvium also occurs in the canyon as debris flows (Hereford et. al., 1997). Intense rainfall in the watershed of side canyons causes flash floods, which in turn cause sediments to accumulate. As the flash flood builds, picking up speed and sediment, more water and sediment are contributed from other side canyons until the flood becomes a viscous mass of sediments that can carry boulders the size of a house. The debris flow travels down the side canyons until it reaches the main canyon, at which point it spews its contents into the river, causing rapids (fig. 23). These materials are too young to have diagnostic soil horizons.

Colluvium

Colluvium is material transported by gravity. Mass wasting is the term used for large scale colluvial processes, and it is the primary process by which the Grand Canyon is enlarged (Beus and Morales, 1990). One process is slab failure, whereby moisture enters rock joints and lubricates slippage planes. Another important process is gravity faulting. High angle gravity faults are brittle failures unrelated to deep-seated tectonic processes (Huntoon, 1990). Gravity faulting is important in generating some of the unique scenery in the canyon, for instance, the isolated buttes and strings of buttes characteristic of the canyon. The majority of side canyons are the result of gravity faults as well.

The large variety of cliffs, slopes, and ledges in the canyon is related to the weathering characteristics of the rocks. Sedimentary rocks are deposited in layers

Figure 23.—A debris flow deposit subsequently cut by another flood event.

that vary in vertical and horizontal extent, depending on the nature of their depositional environment. The degree of induration, lithologic fabric, and weathering characteristics are a function of depositional environment (for example, eolian, fluvial, or marine), diagenetic history (young vs. highly compacted vs. completely metamorphosed) and original sediment type (such as arkosic sand, fluvial silt, or silica flagellates). The overall geomorphology of rock outcrop is an expression of all these variables.

In cases where the depositional layers are very thick and homogenous, there will not be much variation in the surface of the rock outcrop escarpment. The Redwall Formation, for example, is very dense

homogenous limestone that is subject to slab failure. It forms sheer, vertical, tall cliffs. In contrast, where the layers are heterogeneous, features such as ledges, steep toes, ridges, gaps, and notches will be present. These features result from differential weathering of the various depositional layers. The Supai Group contains layers of compact dense sandstone interlayered with soft, easily weathered mudstone. The mudstone undercuts the sandstone and causes slab failure. As a result, there are many horizontal sandstone ledges separated by the slope-forming mudstone.

Colluvial toe slopes and talus slopes are very common throughout the survey area. They are the accumulation of debris resulting from a variety of

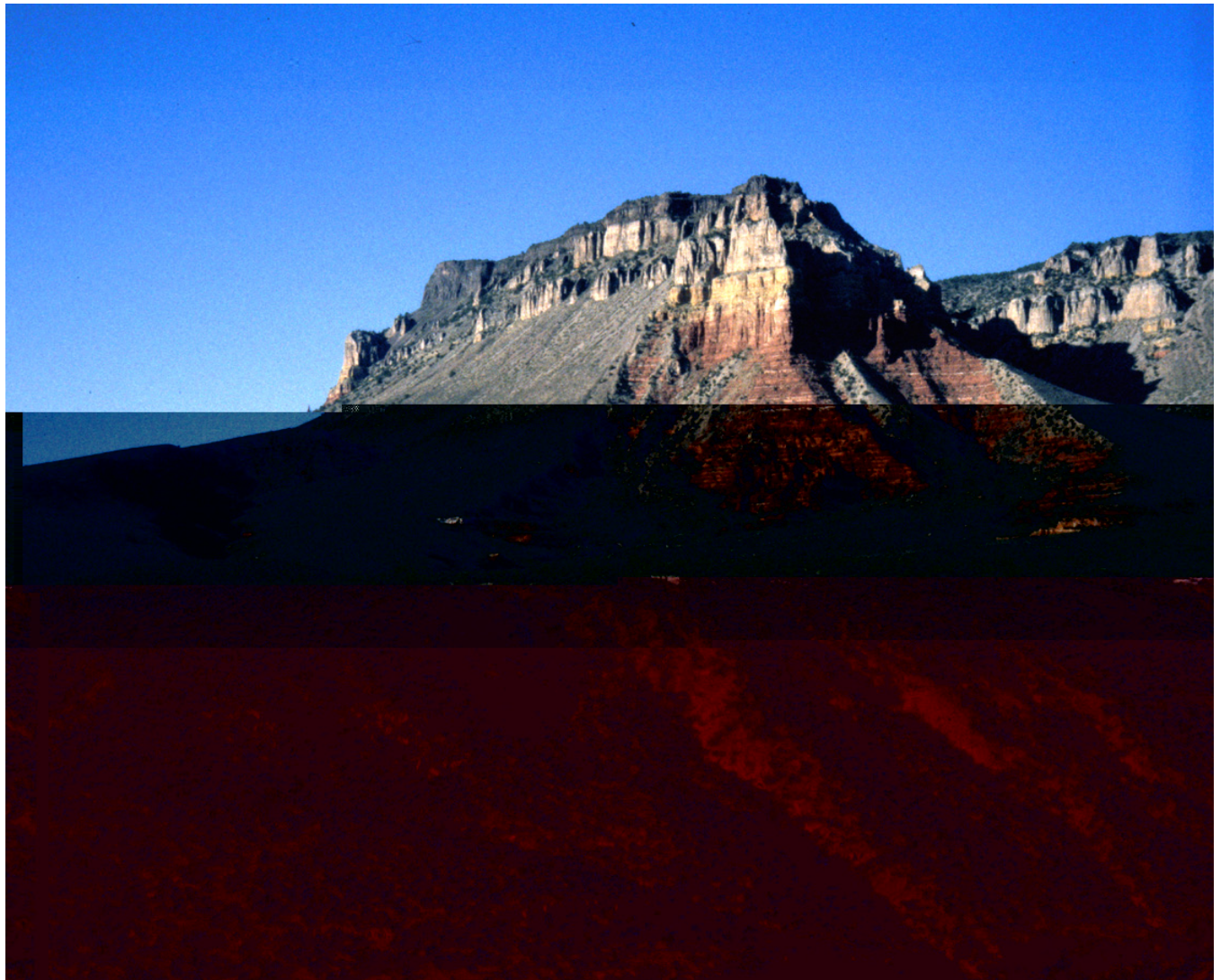


Figure 24.—Fan terraces on plateau escarpments near Snap Point. The foreground consists of gypsiferous sediments of the Hermit Formation.

colluvial processes. Talus slopes are generally so active that they are devoid of vegetation and no soil is present. Colluvial toeslopes, in contrast, have stabilized enough for vegetation to become established.

Colluvial toeslopes may accumulate on slopes or in depressions. Many colluvial toe slopes occur below the faulted area of a gravity fault. Since water may pour over these same areas, it is sometimes difficult to determine if the talus is colluvium or alluvium. If the materials are directly below a sheer cliff it is generally considered colluvium. Material will continue to work its way downslope owing to the combined effects of gravity and water. At this point it is generally considered alluvium, and the landform is referred to as a "fan terrace" (fig. 24).

The youngest talus slopes are at river level where cutting is active. These do not have any diagnostic horizons, and weathering is very minimal. The oldest talus slopes, on the open areas of the Tonto Platform, Esplanade, and Sanup Plateau, have become stabilized by calcium carbonate cementation (calcic and petrocalcic horizons). These are the Winkel family, Curob family, and Dera family soils. These are very old surfaces. In some cases, the rim escarpment has weathered back by slab failure, leaving the top of the talus slope as an isolated point. The talus slopes become younger again as one follows side canyons that are actively eroding into the sides of the rim.

Eolian

Eolian materials are materials transported by wind. Sand dunes are one example of eolian deposits. Sand dunes occur on the larger beaches along the river but they are not very widespread.

The most widespread distribution of eolian materials occurs in talus slopes and pediments above high water marks in the river corridor. Prior to the construction of Glen Canyon Dam, annual flooding occurred in the spring as winter snows melted. The spring floods deposited new sediments on beaches. The lowest flows occurred in the late summer and fall. At these times, wind blowing upriver moved sediments that were previously deposited as alluvium. These materials were blown back up river and deposited along the sides of the river gorge and sides of canyons just above the river. Very fine and fine sands filled the interstices between boulders and stones of talus slopes. These materials helped to make the talus slopes conducive to plant growth and wildlife habitat.

Climate

Climate, past and present, has a strong effect on soil formation. Temperature and moisture affect the rate of weathering of parent material, the activity of microorganisms; and the release, leaching, and accumulation of nutrients. Climate also helps the determine the nature of the plant community growing on the soil, which in turn influences soil development. Wind and water can transport soil material over long distances. Solar radiation affects soil moisture retention, temperature, and oxidation of surface organic matter. In general, the rate of weathering increases as temperature and moisture increase.

Climate is used to classify soils based on the temperature and moisture regime in which they occur. A soil temperature regime is based on the mean annual temperature of the soil at a depth of 20 inches. If bedrock is present or another hard layer occurs that is shallower than 20 inches, then the temperature is the average at the top of the bedrock or other hard layer. The average annual soil temperature in the survey area is about 2 degrees warmer than the average annual air temperature. For example, some of the soils in the survey area have a thermic soil temperature regime, which means that the mean annual soil temperature is not lower than 59degrees F, or higher than 72 degrees F.

Soil moisture regimes are based on the amount of time the soil profile is moist and the time of year that rainfall occurs. Generally speaking, if the soil is dry most of the year, in most years, the soil has an aridic moisture regime. If the soil is frequently moist, in most years, and the rainfall occurs mostly during the growing season, then the soil has an ustic moisture regime. Intergrades, such as ustic-aridic, are allowed. These are defined in Soil Taxonomy (USDA, 1999). The mean soil temperature and the amount of precipitation are given for each soil and each map unit in the detailed map unit descriptions.

Climate depends on many variables. Generally, temperature decreases with elevation and with increase in latitude. Temperature also varies with surface aspect. The result is that there is a regional climate, a local climate, and a microclimate.

Regional climate depends on such things as latitude and proximity to sources of moisture, such as oceans or lakes. Local climate is the regional climate modified by local topographic relief and elevation. Microclimate is the local climate modified by surface aspects (north-facing slopes versus south-facing slopes). The Grand

Canyon has many areas of microclimate as the result of deep canyons and sheer cliffs, and these microclimates are dramatically affected by the direction in which the cliffs and canyons are facing.

The regional climate of the survey area consists of two major types. The western part of the survey area is dominated by hot summers and cool winters. Annual precipitation is low, and most of it falls in winter and comes from the Pacific Ocean. This part of the survey area corresponds to the Mohave Basin and Range Major Land Resource Area (MLRA) west of the Grand Wash Cliffs.

The survey area east of the Grand Wash Cliffs corresponds to the Colorado and Green River MLRA

and is characterized by warm summers and cold winters. Precipitation occurs in the winter and summer. The early summer moisture comes from storms from the Gulf of Mexico. The late summer and winter moisture comes from the Pacific Ocean.

In the Mohave Basin and Range area, only minor variations in local climate occur as the result of elevation but they are very significant. Below about 1,600 feet in elevation, the average annual soil temperature averages from 73degrees to 79degrees F and is classified as having a hyperthermic soil temperature regime. These are the Carrizo, Huevi, Snapcan, and Pompeii soils. From about 1,600 to about 4,500 feet, the soils have an average annual temperature of about 59degrees to 72degrees F and are thermic. These are the Arizo, Bobzbulz, Meadview, and Orrubo soils. The difference between these two temperature regimes is reflected in the plant species diversity and productivity. The hyperthermic soils are the lower of the two.

In the transitional areas between the hyperthermic and thermic, some map units show the effect of surface aspect. North-facing, cooler components of map units are thermic, whereas south-facing, warmer aspects are hyperthermic.

In contrast to the Mohave Basin and Range MLRA, the Colorado and Green River Plateaus show extreme variations in temperature and moisture in the survey area. These variations occur because of the elevation changes of the Kaibab Arch, a geologic uplift in the northeastern part of the survey area that reaches over 9,000 feet in elevation. Consequently, some formations, such as the Muav Formation, range from 1,700 feet elevation at Lake Mead to 7,000 feet on the North Rim. The resulting variation of temperature and moisture is reflected in the vegetation.

Living Organisms

Living organisms that influence soil development include soil microorganisms, plants, and animals. Within the soil, the life processes of bacteria and fungi decompose organic matter and minerals, releasing carbon dioxide, nitrogen, and other essential nutrients to plants. Insects and worms burrow into the soil, causing aeration and mixing of soil particles.



Figure 26.—Gambel oak, turbinella oak, manzanita, and maple occur in thick stands on steep cliffs off the rim on the Kaibab Plateau.

Figure 27.—The influence of the Mohave Desert increases past Whitmore Canyon to the west. Ocotillo, white bursage, and creosotebush are the dominant plants at lower elevations.

physical and chemical soil properties. Distinct plant communities are the result of differences in moisture, temperature, and type of soil.

In the survey area, overall plant distribution is primarily the result of climate and microclimate. The coldest and wettest part of the survey area is also the highest and occurs on the Kaibab Plateau. Vegetation here is characterized by white fir, blue spruce, and aspen (fig. 25). The combination of high precipitation and the acidic nature of spruce and fir residue has resulted in a soil type that exhibits highly weathered characteristics, such as a low pH (high acidity). The parent material on the Kaibab Plateau is mostly the Kaibab Formation, which is highly variable lithologically. However, the variation in lithology types has been minimized because weathering is so severe that the end products are fairly similar. Even at lower elevation where ponderosa pine and aspen are the dominant tree species, specific strata are not recognizable in the parent material. Thick stands of manzanita, desert ceantothus, and turbinella oak occur on the steep canyons below the ponderosa zone (fig. 26).

Ponderosa pine grows on the South Rim of the Grand Canyon, but it is at its lowest limit of moisture tolerance. Pure stands only occur in soils that provide a higher water-holding capacity. Mixed stands of ponderosa pine, pinyon pine, and juniper can be seen around the visitor center but the ponderosa drops out quickly as one passes Grand View point heading east and Bright Angel Wash heading west. This change in vegetation is the result of less moisture and lower elevations. Variations in the pinyon pine/juniper woodlands on the South Rim are discussed in detail in the section on parent material.

The next zone encountered below the pinyon/juniper zone is the sagebrush zone. Broad expanses of sagebrush in the survey area occur mostly on Kanab Point and parts of SB and Tuckup Point. Sagebrush occurs outside the survey area and is one of the most common plants on the Colorado Plateau.

The blackbrush zone occurs below the sagebrush zone and comprises the most widespread vegetation type in the survey area. Blackbrush occurs on the Tonto Platform, the Esplanade, and the Sanup and Hualapai Plateaus. It grows as low as 1,500 feet near

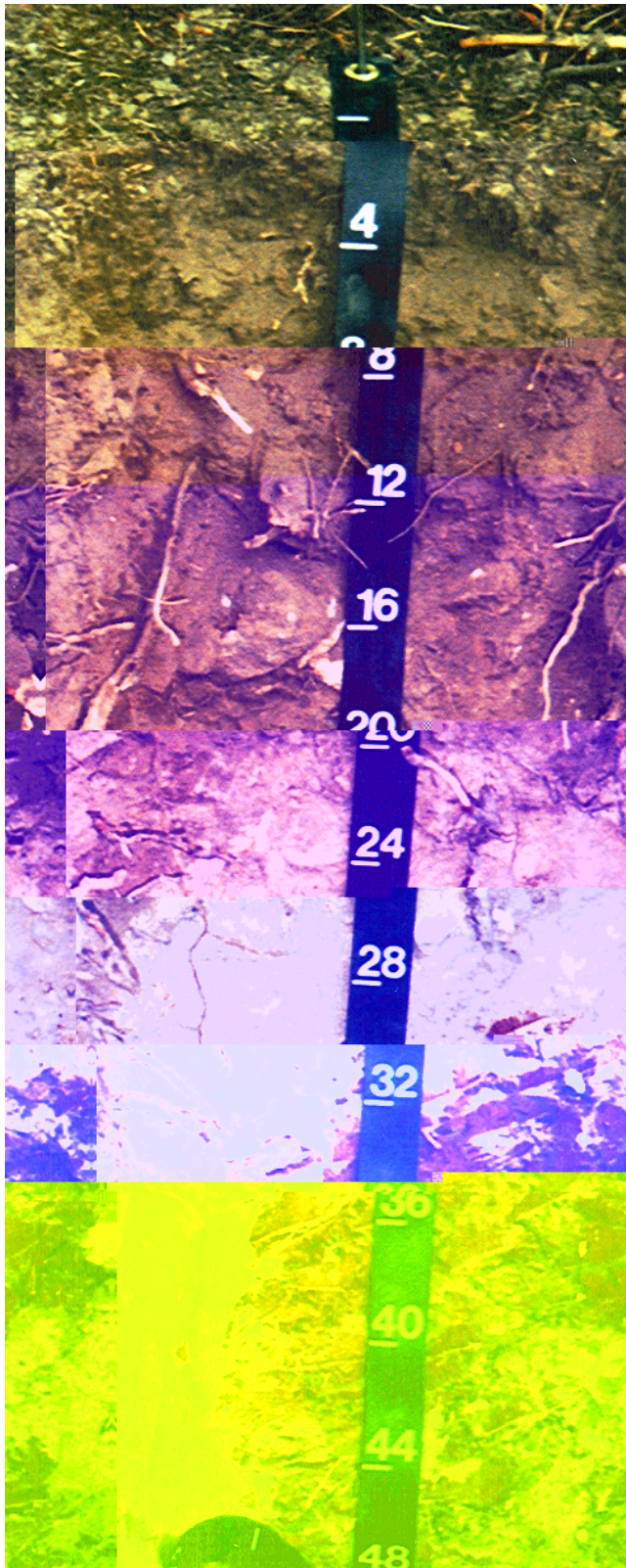


Figure 28.—The Kaiparowits soil series formed in residuum of the Kaibab Formation. It is deep to bedrock and has a heavy clay argillic horizon overlain by a light-colored eluvial zone.

Lake Mead and as high as about 5,000 feet near Snap Point. It occurs on colluvial slopes and pediments.

Below the blackbrush zone are the more heat- and drought-tolerant plants, such as white brittlebush, sandpaper plant, ephedra, wolfberry and desert needlegrass. Along the river corridor beaches, mesquite, arrowweed, and tamarisk are dominant.

West of Whitmore Canyon, plants of the Mohave Basin and Range province, such as creosotebush and white bursage, become consistently present in the river corridor (fig. 27).

The side canyons and riparian areas are host to a diversity of plants such as cottonwood, Arizona walnut, redbud, canyon grape, and monkeyflower if perennial water is present.

Topography

Topography influences soil development through its effect upon water movement and stability of soil material. Steep slopes increase surface water runoff and erosion by water. Soils on steep and very steep slopes are often unstable, and erosion by water occurs faster than processes of soil development. Soils on steep slopes are, therefore, commonly shallow and have poorly developed soil horizons.

Soils on lesser slopes tend to be more stable, and over time they develop distinct soil horizons. Surface runoff from adjoining uplands collects in level to concave areas, bringing with it organic matter and sediments. In these areas of alluvial deposition, the surface horizons are somewhat thicker and higher in organic matter and may form mollic epipedons.

The topography of the survey area is extreme. The plateaus are relatively flat, and the canyon sidewalls are essentially vertical. The soils are shallow on most of the plateaus. This fact suggests that, at some time in the past, the climate was harsh enough to cause severe erosion in spite of the low slopes of the surfaces; or else the parent material is just not conducive to soil formation. There are some places in the survey area where the soils are deep, and these seem to correspond to a parent material that is conducive to soil formation. For example, the Retsover and Pinntank soils on the South Rim are deep soils that formed in argillaceous sandstone. In this area, the slopes are minimal, and the current climate is fairly mild.

In contrast, on the Kaibab Plateau, which receives the highest precipitation in the survey area, the soils are consistently deep even though the slopes are moderately steep. Higher elevations usually cause more precipitation as the result of orogenic uplift.

Uplifted air is cooler and cannot hold as much moisture as warmer air, so that its moisture

precipitates. In this case, the higher precipitation produces more vegetation. Plants protect the soil from erosion, and their roots and residues accelerate soil formation (fig. 28).

The antithesis of orogenic uplift is the “rain shadow” effect. When topographic features cause an air mass to rise and lose its moisture, the air is very dry when it comes down again. Because of the extreme topographical differences in the Grand Canyon, very dry microclimates can be found on the leeward side of plateaus and escarpments.

The Grand Canyon topography illustrates the interactive nature of the soil forming factors. Higher elevations cause higher precipitation. This may cause more erosion but it may also increase plant growth that protects soil from erosion. This example also

illustrates the fragile nature of environments. A stable environment is the result of a delicate balance of the five soil-forming factors.

Time

Time as a soil forming factor refers to the duration that a parent material has been in place and influenced by the other soil forming factors. As a general rule, the more stable a soil is, the older it is and the more developed its morphology will be. For example, unprotected soils on steep slopes and soils in active flood plains are unstable and subject to erosion or deposition. They are, therefore, generally young soils which do not have many, if any, pedogenic soil horizons.

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvial fan. The fanlike deposit of a stream where it issues from a gorge upon a plain or of a tributary stream near or at its junction with its main stream.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Aquic conditions. Current soil wetness characterized by saturation, reduction, and redoximorphic features.

Arch. A fold that is convex upward or had such altitude at some stage of development.

Argillic horizon. A subsoil horizon characterized by an accumulation of illuvial clay.

Aspect. The direction in which a slope faces.

Association, soil. A group of soils or miscellaneous areas geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as:

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Badland. Steep or very steep, commonly nonstony, barren land dissected by many intermittent drainage channels. Badland is most common in semiarid and arid regions where streams are entrenched in soft geologic material. Local relief generally ranges from 25 to 500 feet. Runoff potential is very high, and geologic erosion is active.

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, and K), expressed as a percentage of the total cation-exchange capacity.

Bedding planes. Fine strata, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediment.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bedrock-controlled topography. A landscape where the configuration and relief of the landforms are determined or strongly influenced by the underlying bedrock.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Breaks. The steep and very steep broken land at the border of an upland summit that is dissected by ravines.

Breast height. An average height of 4.5 feet above the ground surface; the point on a tree where diameter measurements are ordinarily taken.

Butte. An isolated small mountain or hill with steep or precipitous sides and a top variously flat, rounded, or pointed that may be a residual mass isolated by erosion or an exposed volcanic neck.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Canopy. The leafy crown of trees or shrubs. (See Crown.)

Canyon. A long, deep, narrow, very steep sided valley with high, precipitous walls in an area of high local relief.

Cation. An ion carrying a positive charge of electricity.

The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Channery soil material. Soil material that has, by volume, 15 to 35 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches (15 centimeters) along the longest axis. A single piece is called a chanter.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Cliff-former. A geologic strata or rock layer that is coherent to such a degree that the erosion surface is vertical or near vertical.

Coarse textured soil. Sand or loamy sand.

Cobble (or cobblestone). A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Cobbly soil material. Material that has 15 to 35 percent, by volume, rounded or partially rounded rock fragments 3 to 10 inches (7.6 to 25 centimeters) in diameter. Very cobbly soil material has 35 to 60 percent of these rock fragments, and extremely cobbly soil material has more than 60 percent.

Colluvium. Soil material or rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A map unit of two or more kinds of soil or miscellaneous areas in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas.

Concretions. Cemented bodies with crude internal symmetry organized around a point, a line, or a plane. They typically take the form of concentric layers visible to the naked eye. Calcium carbonate, iron oxide, and manganese oxide are common compounds making up concretions. If formed in place, concretions of iron oxide or

manganese oxide are generally considered a type of redoximorphic concentration.

Conglomerate. A coarse grained, clastic rock composed of rounded or subangular rock fragments more than 2 millimeters in diameter. It commonly has a matrix of sand and finer textured material. Conglomerate is the consolidated equivalent of gravel.

Consistence, soil. Refers to the degree of cohesion and adhesion of soil material and its resistance to deformation when ruptured. Consistence includes resistance of soil material to rupture and to penetration; plasticity, toughness, and stickiness of puddled soil material; and the manner in which the soil material behaves when subject to compression. Terms describing consistence are defined in the "Soil Survey Manual."

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosion. Soil-induced electrochemical or chemical action that dissolves or weakens concrete or uncoated steel.

Depth, soil. Generally, the thickness of the soil over bedrock. Very deep soils are more than 60 inches deep over bedrock; deep soils, 40 to 60 inches; moderately deep, 20 to 40 inches; shallow, 10 to 20 inches; and very shallow, less than 10 inches.

Dip slope. A slope of the land surface, roughly determined by and approximately conforming to the dip of the underlying bedrock.

Drainage class (natural). Refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized—*excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained*. These classes are defined in the "Soil Survey Manual."

Drainage, surface. Runoff, or surface flow of water, from an area.

Duff. A generally firm organic layer on the surface of mineral soils. It consists of fallen plant material that is in the process of decomposition and includes everything from the litter on the surface to underlying pure humus.

Ecological site. An area where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. An ecological site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other ecological sites in kind and/or proportion of species or in total production.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Escarpment. A relatively continuous and steep slope or cliff breaking the general continuity of more gently sloping land surfaces and resulting from erosion or faulting. Synonym: scarp.

Fan terrace. A relict alluvial fan, no longer a site of active deposition, incised by younger and lower alluvial surfaces.

Fanglomerate. Heterogenous materials that were deposited in an alluvial fan which have become cemented into solid rock.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the oven-dry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity*, *normal moisture capacity*, or *capillary capacity*.

Fine textured soil. Sandy clay, silty clay, or clay.

Flaggy soil material. Material that has, by volume, 15 to 35 percent flagstones. Very flaggy soil material has 35 to 50 percent flagstones, and extremely

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characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying soil material. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon, but it can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff potential. The soil properties that influence this potential are those that affect the minimum rate of water infiltration on a bare soil during periods after prolonged wetting when the soil is not frozen. These properties are depth to a seasonal high water table, the infiltration rate and permeability after prolonged wetting, and depth to a very slowly permeable layer. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intermittent stream. A stream, or reach of a stream, that flows for prolonged periods only when it receives ground-water discharge or long, continued contributions from melting snow or other surface and shallow subsurface sources.

Karst (topography). The relief of an area underlain by limestone that dissolves in differing degrees, thus forming numerous depressions or small basins.

K_{sat} . Saturated hydraulic conductivity. (See Permeability.)

Lacustrine deposit. Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Leaching. The removal of soluble material from soil or other material by percolating water.

Linear extensibility. Refers to the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state. Linear extensibility is used to determine the shrink-swell potential of soils. It is an expression of the volume change between the water content of the clod at $1/3$ - or $1/10$ -bar tension (33kPa or 10kPa tension) and oven dryness. Volume change is influenced by the amount and type of clay minerals in the soil. The volume change is the percent change for the whole soil. If it is expressed as a fraction, the resulting value is COLE, coefficient of linear extensibility.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Lithology. The physical character of a rock, generally as determined megascopically (with the unaided eye) or with the aid of a low-power magnifier.

Lithosphere. The silicate shell of the earth; includes mantle and crust.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Masses. Concentrations of substances in the soil matrix that do not have a clearly defined boundary with the surrounding soil material and cannot be removed as a discrete unit. Common compounds making up masses are calcium carbonate, gypsum or other soluble salts, iron oxide, and manganese oxide. Masses consisting of iron oxide or manganese oxide generally are considered a type of redoximorphic concentration.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mesa. A broad, nearly flat topped and commonly isolated upland mass characterized by summit widths that are more than the heights of bounding erosional scarps.

Metamorphic rock. Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, or fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, or silty clay loam.

Mollic epipedon. A thick, dark, humus-rich surface horizon (or horizons) that has high base saturation and pedogenic soil structure. It may include the upper part of the subsoil.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Descriptive terms are as follows: abundance—*few*, *common*, and *many*; size—*fine*, *medium*, and *coarse*; and contrast—*faint*, *distinct*, and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Mountain. A natural elevation of the land surface, rising more than 1,000 feet above surrounding lowlands, commonly of restricted summit area (relative to a plateau) and generally having steep sides. A mountain can occur as a single, isolated mass or in a group forming a chain or range.

Mudstone. Sedimentary rock formed by induration of silt and clay in approximately equal amounts.

Neutral soil. A soil having a pH value of 6.6 to 7.3. (See Reaction, soil.)

Nodules. Cemented bodies lacking visible internal structure. Calcium carbonate, iron oxide, and manganese oxide are common compounds making up nodules. If formed in place, nodules of iron oxide or manganese oxide are considered types of redoximorphic concentrations.

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pediment. A thin layer of alluvial material that mantles an erosion surface and has been transported to its present position from higher lying areas of the erosion surface.

Pedon. The smallest volume that can be called “a soil.” A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The movement of water through the soil.

Permeability. The quality of the soil that enables water or air to move downward through the profile. The rate at which a saturated soil transmits water is accepted as a measure of this quality. In soil physics, the rate is referred to as “saturated hydraulic conductivity,” which is defined in the “Soil Survey Manual.” In line with conventional usage in the engineering profession and with traditional usage in published soil surveys, this rate of flow continues to be expressed as “permeability.”

Phase, soil. A subdivision of a soil series based on features that affect its use and management, such as slope, stoniness, and flooding.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plateau. An extensive upland mass with relatively flat summit area that is considerably elevated (more than 100 meters) above adjacent lowlands and separated from them on one or more sides by escarpments.

Playa. The generally dry and nearly level lake plain that occupies the lowest parts of closed depressional areas, such as those on intermontane basin floors. Temporary flooding occurs primarily in response to precipitation and runoff.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Prescribed burning. Deliberately burning an area for specific management purposes, under the appropriate conditions of weather and soil moisture and at the proper time of day.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

Ultra acid	less than 3.5
Extremely acid	3.5 to 4.4
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Moderately acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Slightly alkaline.....	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Redoximorphic concentrations. Nodules, concretions, soft masses, pore linings, and other features resulting from the accumulation of iron or manganese oxide. An indication of chemical reduction and oxidation resulting from saturation.

Redoximorphic depletions. Low-chroma zones from which iron and manganese oxide or a combination of iron and manganese oxide and clay has been removed. These zones are indications of the chemical reduction of iron resulting from saturation.

Redoximorphic features. Redoximorphic concentrations, redoximorphic depletions, reduced matrices, a positive reaction to alpha,alpha-dipyridyl, and other features indicating the chemical reduction and oxidation of iron and manganese compounds resulting from saturation.

Reduced matrix. A soil matrix that has low chroma in situ because of chemically reduced iron (Fe II). The chemical reduction results from nearly continuous wetness. The matrix undergoes a change in hue or chroma within 30 minutes after exposure to air as the iron is oxidized (Fe III). A type of redoximorphic feature.

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-sized particles.

Saturation. Wetness characterized by zero or positive pressure of the soil water. Under conditions of saturation, the water will flow from the soil matrix into an unlined auger hole.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Side slope. A geomorphic component of hills consisting of a laterally planar area of a hillside. The overland waterflow is predominantly parallel.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Sinkhole. A depression in the landscape where limestone has been dissolved.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope-former. A geologic strata or rock layer where the degree of coherence or consolidation is such that the erosion surface is inclined.

Sodic (alkali) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Sodicity. The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium adsorption ratio (SAR) of a saturation extract, or the ratio of Na^+ to $\text{Ca}^{++} + \text{Mg}^{++}$. The degrees of sodicity and their respective ratios are:

Slight	less than 13:1
Moderate	13-30:1
Strong	more than 30:1

Sodium adsorption ratio (SAR). A measure of the amount of sodium (Na) relative to calcium (Ca) and magnesium (Mg) in the water extract from saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration.

Soft bedrock. Bedrock that can be excavated with trenching machines, backhoes, small rippers, and other equipment commonly used in construction.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the material below the solum. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60

centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subduction. Descent of one tectonic unit under another. Most commonly used for descent of a slab of lithosphere, but appropriate at any scale. Refers to the process, not the site.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Summit. The topographically highest position of a hillslope. It has a nearly level (planar or only slightly convex) surface.

Talus. Fragments of rock and other soil material accumulated by gravity at the foot of cliffs or steep slopes.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior. Soils are recognized as taxadjuncts only when one or more of their characteristics are slightly outside the range defined for the family of the series for which the soils are named.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand*, *loamy sand*, *sandy loam*, *loam*, *silt loam*, *silt*, *sandy clay loam*, *clay loam*, *silty clay loam*, *sandy clay*, *silty clay*, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Travertine formation. An area of material naturally formed from calcium carbonate, CaCO_3 , deposited from solution in ground and surface waters.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

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